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J. L. Van Kirk, R. L. Stoughton, J. R. Stoker and E. F. Nordlin

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16. ABSTRACT

A vehicular impact test was conducted which determined the strength and stability of steel channel beams (gap beam design) spanning a 4-foot gap, at midlength, in a concrete median barrier (CMB). The gap beam design is intended for use where catch basins are on the centerline of the CMB.

The test parameters were as follows:
Test 361 - 4,410 lb vehicle/61 mph/23 degrees

The barrier was a continuous CMB with a New Jersey profile. It had moderately reinforced end anchor sections with 10 inch deep footings that extended for 10 feet on both sides of the gap. The remainder of the test barrier had no footing.

Based on the results of this study it was concluded that the gap beam design and the adjoining concrete barrier end anchors were capable of withstanding impacts as severe as those for which the CMB is designed. Careful attention should be given to the dimensions of the CMB end anchors and gap beam components during fabrication and construction. With this dimensional control accomplished, the gap beam elements were installed quickly and easily.

17. KEY WORDS
Barriers, catch basins, dynamic tests, impact tests, median barriers, reinforced concrete, vehicle dynamics

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STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION
OFFICE OF TRANSPORTATION LABORATORY

February 1979

TL No. 646931

Mr. C. E. Forbes
Chief Engineer

Dear Sir:

I have approved and now submit for your information this final research report titled:

VEHICULAR IMPACT TEST ON STEEL
CHANNEL BEAMS SPANNING A GAP IN A
CONTINUOUS CONCRETE MEDIAN BARRIER

Study made by . . . . Structural Materials Branch

Under the Supervision of . . . E. F. Nordlin, P.E.

Principal Investigator . . . . J. R. Stoker, P.E.

Co-Principal Investigator . . . R. L. Stoughton, P.E.

Co-Investigator . . . . D. M. Parks, P.E.
and
J. L. Van Kirk

Report Prepared by . . . . J. L. Van Kirk

Very truly yours,

Neal Andersen

NEAL ANDERSEN
Chief, Office of Transportation Laboratory

Attachment
JLVK:cj

ACKNOWLEDGEMENTS

Special appreciation is due the following staff members of the Transportation Laboratory who were instrumental in the successful completion of the test, construction of the barrier, and in the preparation of this report:

Jim Keesling	In charge of photo and electronic instrumentation data reduction, prepared the movie report; helped conduct the test; and assisted with barrier construction.
Roy Steiner	In charge of preparation and operation of the test vehicle and other test equipment; and helped conduct the test.
Robert Mortensen	Data and documentary photography.
Richard Johnson Delmar Gans William Ng	Electronic instrumentation of the test vehicle and dummy.
Elmer Wigginton	Drafting of tables, figures, and instrumentation data traces.
Ed Budney	Assisted with barrier construction and testing.
Larry Stevens	Reproduction.

Appreciation is also due the following personnel from the California Department of Transportation who were available for technical consultation and advice during the project:

Ed Tye	Office of Traffic Engineering
Ralph Bishop	Office of Structures Design
John Evans	Headquarters Value Engineering Branch
Bob Branch	District 07 Value Engineering Team

CONVERSION FACTORS

English to Metric System (SI) of Measurement

Quanity	English unit	Multiply by	To get metric equivalent
Length	inches (in)or(")	25.40 .02540	millimetres (mm) metres (m)
	feet (ft)or(')	.3048	metres (m)
	miles (mi)	1.609	kilometres (km)
Area	square inches (in^2) square feet (ft^2) acres	6.432×10^{-4} .09290 .4047	square metres (m^2) square metres (m^2) hectares (ha)
Volume	gallons (gal) cubic feet (ft^3) cubic yards (yd^3)	3.785 .02832 .7646	litres (l) cubic metres (m^3) cubic metres (m^3)
Volume/Time			
(Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
Mass	pounds (lb)	.4536	kilograms (kg)
Velocity	miles per hour(mph) feet per second(fps)	.4470 .3048	metres per second (m/s) metres per second (m/s)
Acceleration	feet per second squared (ft/s^2)	.3048	metres per second squared (m/s^2)
	acceleration due to force of gravity(G)	9.807	metres per second squared (m/s^2)
Weight Density	pounds per cubic (lb/ft^3)	16.02	kilograms per cubic metre (kg/m^2)
Force	pounds (lbs) kips (1000 lbs)	4.448 4.448	newtons(N) newtons (N)
Thermal Energy	British thermal unit (BTU)	1055	joules (J)
Mechanical Energy	foot-pounds(ft-lb) foot-kips (ft-k)	1.356 1.356	joules (J) joules (J)
Bending Moment or Torque	inch-pounds(ft-lbs) foot-pounds(ft-lbs)	.1130 1.356	newton-metres (Nm) newton-metres (Nm)
Pressure	pounds per square inch (psi)	6895	pascals (Pa)
	pounds per square foot (psf)	47.88	pascals (Pa)
Stress Intensity	kips per square inch square root inch (ksi $\sqrt{in}$)	1.0988	mega pascals $\sqrt{metre}$ (MPa $\sqrt{m}$)
	pounds per square inch square root inch (psi $\sqrt{in}$)	1.0988	kilo pascals $\sqrt{metre}$ (KPa $\sqrt{m}$)
Plane Angle	degrees (°)	0.0175	radians (rad)
Temperature	degrees fahrenheit (F)	$\frac{tF - 32}{1.8} = tC$	degrees celsius (°C)

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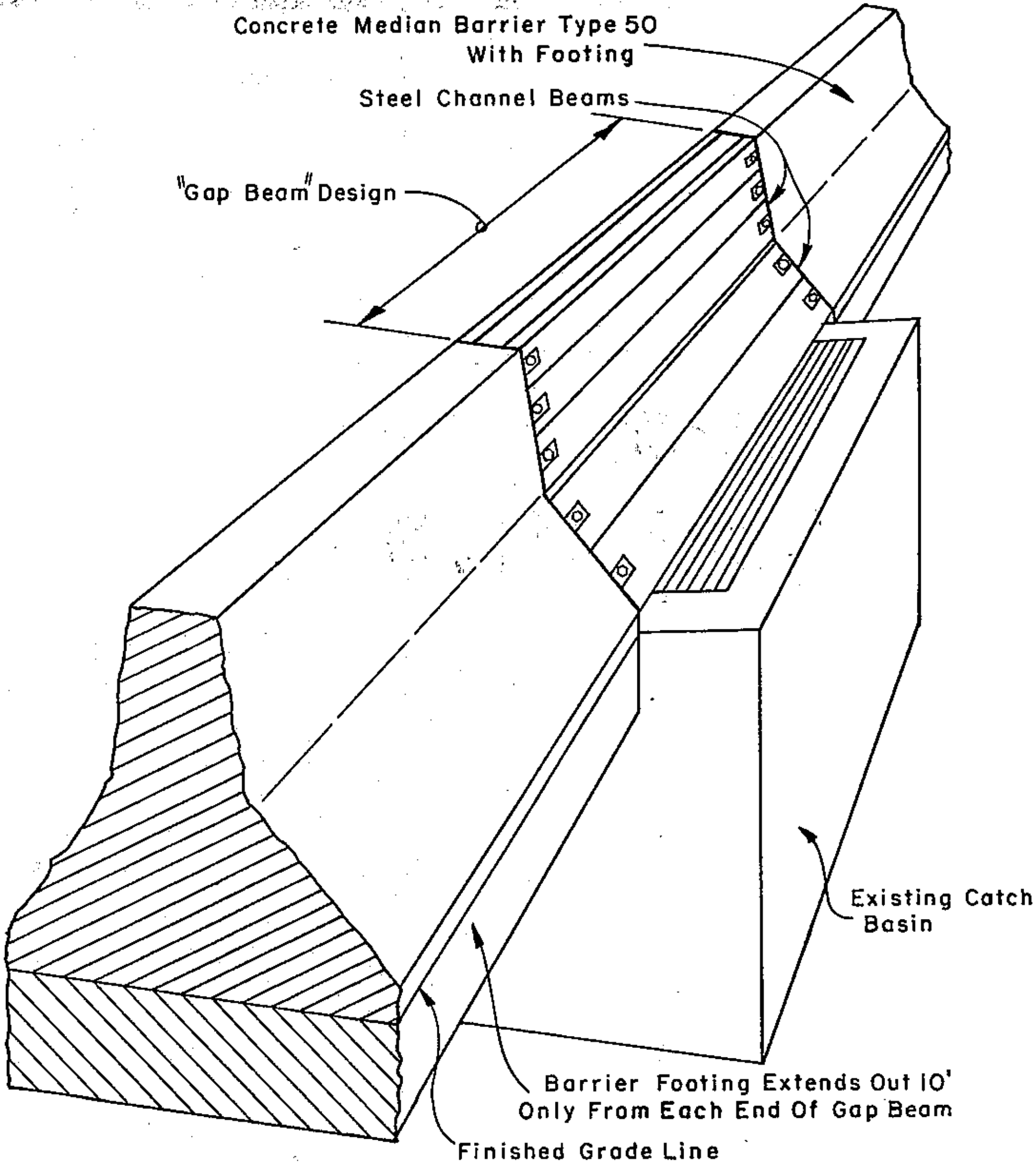


PERSPECTIVE VIEW OF STEEL CHANNEL BEAMS
SPANNING A GAP
IN CONCRETE MEDIAN BARRIER

Figure 1

INTRODUCTION

Many new miles of concrete median barrier (CMB) will be constructed on California highways in the near future. About 200 miles are planned for the Los Angeles area alone within the next five years. On many exisitng freeways, V-shaped medians were constructed with storm drain systems designed to collect runoff from the median and adjacent freeway lanes. Since both existing catch basins and CMB are placed on the centerline of the freeway, these catch basins will interfere with the barrier on new CMB projects. For this reason it has been proposed that gaps be left in the CMB at catch basin locations. Steel channel beams would be used to span these gaps and would follow the safety shape contours, Figure 1. These beams would be C6x8.2 rubrail salvaged from replaced metal beam barriers. This steel channel beam system will be referred to throughout this report as the "gap beam" design.

There was an extensive investigation of this problem made by the District 07 Value Engineering Team of the California Department of Transportation (Caltrans) and the results are described in a report titled "Catch Basins on Concrete Median Barrier Projects"(1)*. Presently the catch basins are either widened and bridged with CMB or a gap is left in the CMB over the catch basin and it is spanned with steel closure plates. As a result of the Value Engineering study, it was determined that by using the gap beam design instead of the present methods, there could be a considerable savings in construction and maintenance costs. By implementing the gap beam design it would also create safer and simpler construction and maintenance operations.

*Number underlined in parentheses refers to a reference list at the end of this report.

A structural analysis of the gap beam design was attempted. Due to the complexity of the actual dynamic loading on CMB from impacting vehicles, determining the limiting strength of the barrier design by the use of analytical methods was not conclusive. Therefore it was decided that a vehicular impact test should be conducted on the gap beam design proposed in the Value Engineering study.

The objective of this project was to test the strength and stability of the gap beam design. This report describes the results of a vehicular impact, 4,410 lb vehicle/61 mph/ 23 degrees, into a CMB containing the gap beam design shown in Figure 2 in the Technical Discussion section of this report.

The two 10 foot sections to which the gap beam was attached (Figure 2) were "Barrier End Anchors" as shown on California Standard Plan Sheet A75-A.5, Figure 11A in the Appendix. Prior to the initiation of this project a concrete median barrier end anchor had never been tested. As a result of the vehicular impact test, the barrier end anchor was subjected to the same impact loads as the gap beam design, and these results are also included in this report.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The following conclusions were based on the results of a 4,410 lb vehicle/61 mph/23 degree impact test, Test 361, into a concrete median barrier (CMB) which contained a gap beam design spanning a 4 foot long gap in the middle of the barrier:

- The gap beam design had sufficient strength and stability to withstand a vehicular impact as severe as that for which CMB has been tested. The structural damage was limited to a maximum permanent deflection, in the top two steel channel beams, of 1/4 inch. There was no other damage to the connections or members in the gap beam assembly.

- The barrier containing the gap beam design effectively redirected the test vehicle. The gap beam did not adversely influence the redirection of the impacting test vehicle.

- The post crash test vehicle trajectory might have extended into a traffic lane, had it occurred on a highway, depending on the median and shoulder widths. However, the resting place of the vehicle would have been up against the face of the barrier.

- The 10 foot long concrete barrier end anchors on each side of the gap beam proved to be capable of withstanding an impact, as severe as that for which CMB has been tested, without movement or structural damage.

* Proper fitting of the steel channel beams to match the adjoining concrete barrier safety shape required careful control in setting forms, placing concrete, locating embedded threaded rods, and fabricating the components in the gap beam design. If the dimensions for all these elements are controlled, the gap beam components are easy to install or remove.

Recommendations

The following recommendations are based on the results of Test 361 described in this report, and on first-hand installation experience of the gap beam design acquired during this project:

* The gap beam design shown in Figure 10A in the Appendix can safely be installed at 4 foot openings in CMB where catch basins are located or required.

* A systematic installation and fabrication procedure should be followed to insure proper fitting of the gap beam design. A recommended procedure is contained in the Appendix of this report.

* Where a gap beam design is to be installed, the barrier end anchor should not be slipformed, but rather should be formed and the concrete cast in place for better quality control of the safety shape dimensions.

IMPLEMENTATION

As a result of this project, plans have been drawn of the "Gap Beam" design by the Office of Structures Design under the title "Concrete Barrier Type 50 Steel Channel Closure Detail", Figure 10A in the Appendix. The completed plans will be reviewed by the District 07 Value Engineering Team of Caltrans for their evaluation.

The results, conclusions and recommendations of this report will be reviewed by the Office of Traffic Engineering and any further implementation will be initiated by that office.

TECHNICAL DISCUSSION

Test Conditions

Test Facility - The vehicular impact test was conducted at the Caltrans Dynamic Test Facility in Bryte, California. The test area is flat and covered with asphaltic concrete pavement. On test day the weather conditions were clear, warm, and windy.

Test Barrier - Design and Construction - An existing test barrier was modified for the test. It was a 120 foot long, continuous Type 50 concrete median barrier (CMB), with a New Jersey profile. The barrier was cast in-place without a footing on top of a 2-1/2 inch thick asphaltic concrete surface. It was reinforced with two #4 rebars in the stem, placed 6 and 12 inches down from the top of the barrier, Figure 2. It did not contain the two additional #4 rebars that are currently required in the base of the Type 50 CMB. See Figure 11A in the Appendix. Compressive strength of the concrete at 28 days was 4,504 psi.

This barrier had been subjected to one vehicular impact test - 4,700 lbs/61 mph/26 degrees - at midlength(2). The barrier sustained no apparent damage or movement during that impact.

There were no construction or contraction joints in the existing barrier section; however, random shrinkage cracks were noted at 26.3, 30.3, 37.0, 40.8, 75.4, and 93.0 feet from the upstream end, on both sides of the barrier.

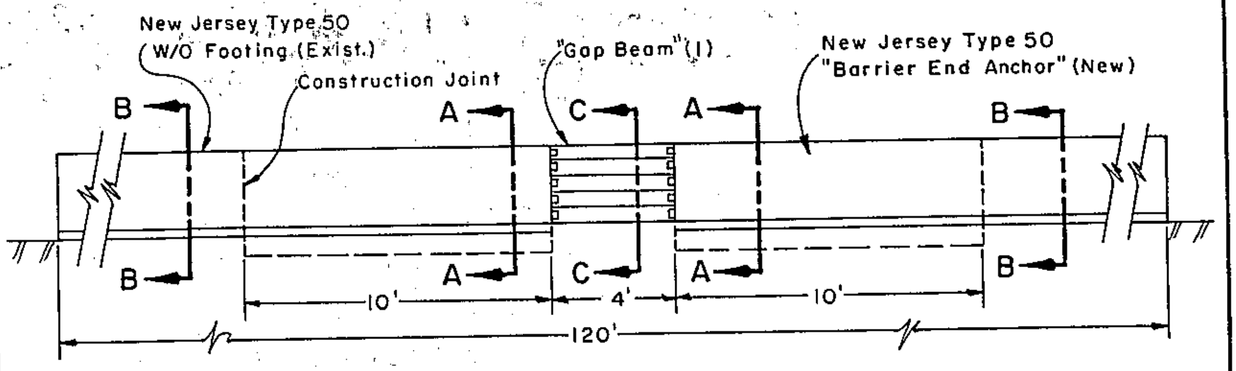
The existing barrier was modified for the test by removing a 24 foot section at midlength. The barrier was then replaced for a length of 10 feet in from each end of the gap, with similar type barrier having a 24-inch wide by 10 inch deep footing, leaving a final gap of 4 feet, Figure 2. The old CMB end surfaces which were saw cut were bush hammered, cleaned, and wet down prior to placing the concrete for the new 10 foot sections of CMB. These 10 foot long modified ends were identical to "Barrier End Anchor" shown on the 1977 Standard Plan Sheet A75-A.5, Figure 11A in the Appendix.

Construction joints occurred between the old and new barrier segments at 47.8 and 72.1 feet from the upstream end of the barrier. Rebar dowels were placed across these joints at the location of the four #4 continuous rebars in the new barrier, to make the completed barrier as continuous as possible.

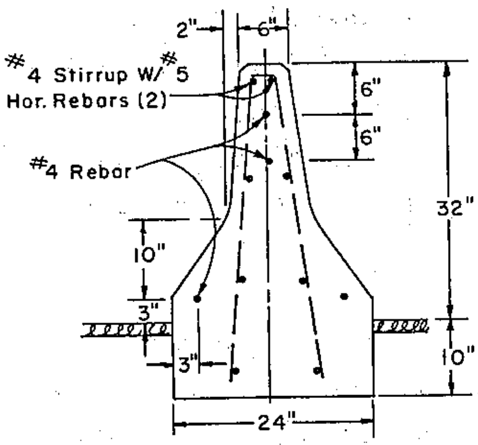
A concrete mix design with 6 sacks of portland cement per cubic yard and one inch maximum size aggregate was used for the existing barrier and the new sections. This mix design was similar to that typically used for constructing CMB with a slipforming machine. The 28 day compressive strength for the new sections was 3,825 psi.

The remaining 4 foot gap was spanned with an assemblage of steel hangers and beams, the "gap beam design". Figures 2 and 3 show the main elements of that design. Complete details of the gap beam design are shown in the Appendix, Figure 10A.

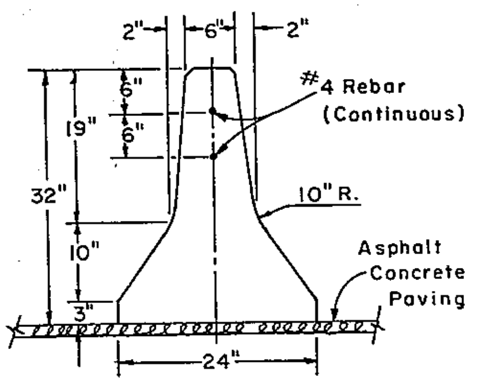
Figure 2, GAP BEAM SUMMARY SHEET*



BARRIER ELEVATION



SECTION A-A



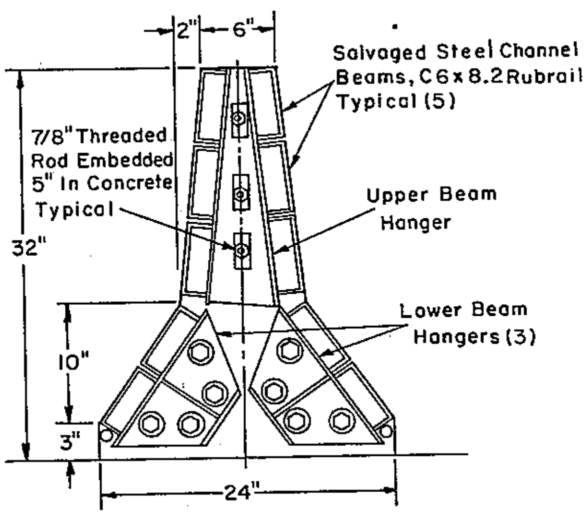
SECTION B-B

NOTES:

1. For a complete set of Gap Beam plans, see appendix.
2. Horizontal rebars extend 5' out from Gap Beam face on both sides.
3. Upper and lower beam hangers were cut from salvaged C6x8.2 steel channel.
4. #4 Rebar dowels were placed across the construction joint.
5. Steel channel beams were bolted at each end to the beam hangers.

METRIC CONVERSIONS

1 in. = 25.4 mm   1 ft. = 0.305 m



SECTION C-C

* NO SCALE

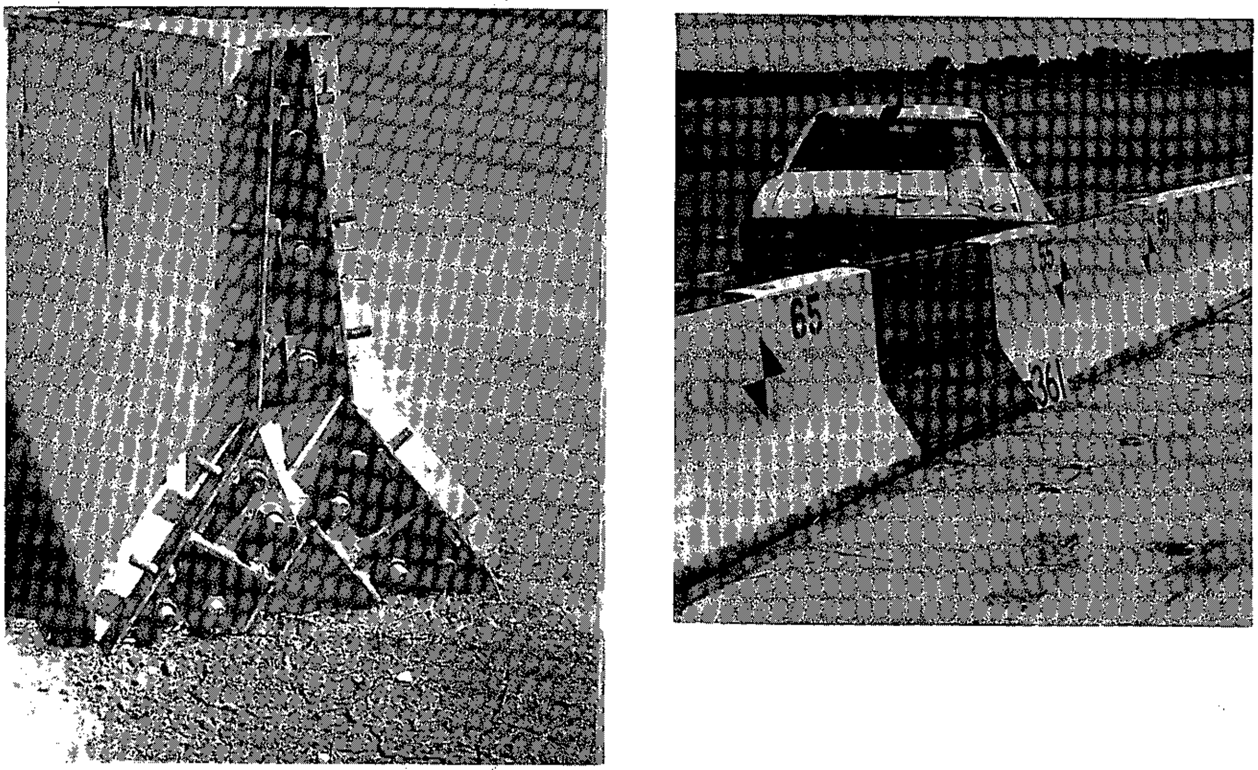


Figure 3 - Main Elements of Gap Beam Design

Threaded rods 7/8 inch in diameter, were cast in place in the ends of the new sections of CMB. They were embedded 5 inches in the concrete. The upper and lower beam hanger brackets, which were cut from pieces of C6x8.2 steel channel rubrail, were then bolted on and adjusted, making sure the beams would be flush with the outside face of the barrier. The nuts were torqued to 150 ft-lbs. Finally the channel beams, C6x8.2, were bolted on to the hanger brackets. The nuts were torqued

to 50 ft-lbs. The nuts were torqued to values that represented a snug wrench-tight condition which might be expected in the field. It also was desired to have known, uniform torque values for the test even though torque values will not be specified on the gap beam plans. Two men mounted the hangers and beams easily in about one hour. All gap beam components were galvanized prior to cutting and fabrication. All cutting of the slots in the beams and hangers were done with a torch to simulate field procedures. The beams and hangers were cut and welded in the shop, but could have been cut with a torch.

Test Vehicle - A 1974 Ford Gran Torino weighing 4,410 lbs was used for Test 361. The vehicle weight included onboard instrumentation and one dummy. The vehicle was in good condition, free of body damage and missing structural parts.

The vehicle was self-propelled. Guidance was achieved with an anchored cable and there were no constraints placed on the steering wheel. A short distance before the point of impact the vehicle ignition was turned off and the vehicle was released from the guidance cable. The vehicle brakes were applied remotely after the vehicle had impacted the barrier and established a post-impact trajectory. A detailed description of the vehicle equipment and guidance system is contained in the Appendix.

Data Acquisition Systems - High speed and normal speed movie cameras and still cameras were used to record the impact events and the conditions of the vehicle and the barrier before and after impact.

An anthropomorphic dummy with accelerometers mounted in its head cavity was placed in the driver's seat to obtain motion and deceleration data. The dummy, Sierra Stan, Model P/N 292-850, manufactured by the Sierra Engineering Company, is a 50th percentile male weighing 165 lbs. The dummy was restrained by a standard lap belt and shoulder belt during the test.

Accelerometers were also mounted on the floorboard of the test vehicle. Deceleration data were collected to judge impact severity and to evaluate vehicle occupant injury tolerances.

The Appendix contains a detailed description of: photographic equipment and data collection techniques, electronic instrumentation and data reduction methods, and accelerometer records.

Impact Location - Several variables were considered in determining where to impact the test barrier containing the gap beam, to insure that the gap beam received the maximum impact load.

Southwest Research Institute (SwRI) conducted a test with very similar test conditions specifically to measure impact loads on the barrier using four load cells for measurement(3). They determined the point of maximum force of the vehicle on the barrier and the time after impact when it occurred. Using the SwRI results a point of impact on the CMB was determined which would permit the test vehicle to exert its maximum force on the gap beam.

The point of initial contact is not the point of maximum impact force of the vehicle on the barrier. This force occurs a short time after impact downstream from the point of contact. It takes time for a peak force to build up while the front end of the vehicle is crushing. The point of peak force can be influenced by different factors, such as vehicle weight and size, crushability of the front of the vehicle, and overhang of the front end over the front axle. These factors were considered, along with the barrier contact distances from other tests (see Table 1 of the Discussion of Results section of this report) in selecting a point of impact.

It was decided to impact the vehicle at 5.2 feet upstream from the face of the 4 foot gap. This should have put the point of maximum force directly on the center of the gap beam. It would also have allowed the leading contact point of the vehicle to pass along the gap beam from 65 to 115 milliseconds after impact. The time of maximum force on the barrier in the SwRI test occurred 80 milliseconds after impact. The vehicle used in Test 361 actually impacted the barrier 9 inches upstream from the intended impact location, and passed along the gap beam from 67 to 111 milliseconds after impact. This impact location should have put the point of maximum force on the gap beam.

Test Results

Test 361: 4,410 lb vehicle/61 mph/23 degrees

Impact Description - The left front bumper of the test vehicle impacted the 120 foot barrier at 67.9 feet from its downstream end and 5.9 feet upstream from the beginning of the gap beam. While being redirected, the test vehicle rode up the face of the barrier and across the face of the gap beam while rolling clockwise, and remained in contact for about 14.5 feet. The vehicle continued off the barrier at an exit angle of about 7 degrees while rolling counterclockwise back to a level horizontal position and yawing slightly clockwise. The vehicle remained upright but began skidding and yawing counterclockwise over 90 degrees until it was perpendicular to the center line of the barrier. The vehicle continued skidding until it bumped a precast barrier section at low speed about 128 feet from the end of the barrier. The precast barrier section was moved about one foot. It was placed in this location to protect three downstream cameras. This precast barrier restricted the total distance the vehicle would have traveled. The vehicle stopped perpendicular to the longitudinal center line of the test barrier with its bumper over a point which was in line with the front edge of the barrier. Figure 9 at the end of the Test Results section of this report summarizes the data from the test and includes sequential impact photographs and a vehicle trajectory diagram.

The vehicle behavior during the post impact trajectory was typical of impacts of this kind. There are many factors which can influence post impact trajectory, such as exit speed and angle, wheel damage during impact, or the application of brakes after impact.

Gap Beam Performance and Damage - The gap beam sustained only minimal damage. The first three beams starting from the top of the barrier on the impact face were the only ones damaged. The top beam was bowed in permanently about 1/8 inch. The second beam was bowed in permanently about 1/4 inch. The third beam was not bowed. All three beams were scuffed and scraped as shown in Figure 4, but there was no apparent structural damage. The beams did not move in any other way. The two bottom beams were unmarked and showed no apparent damage of any kind. All beam and beam hanger connections showed no movement or failure of any kind.

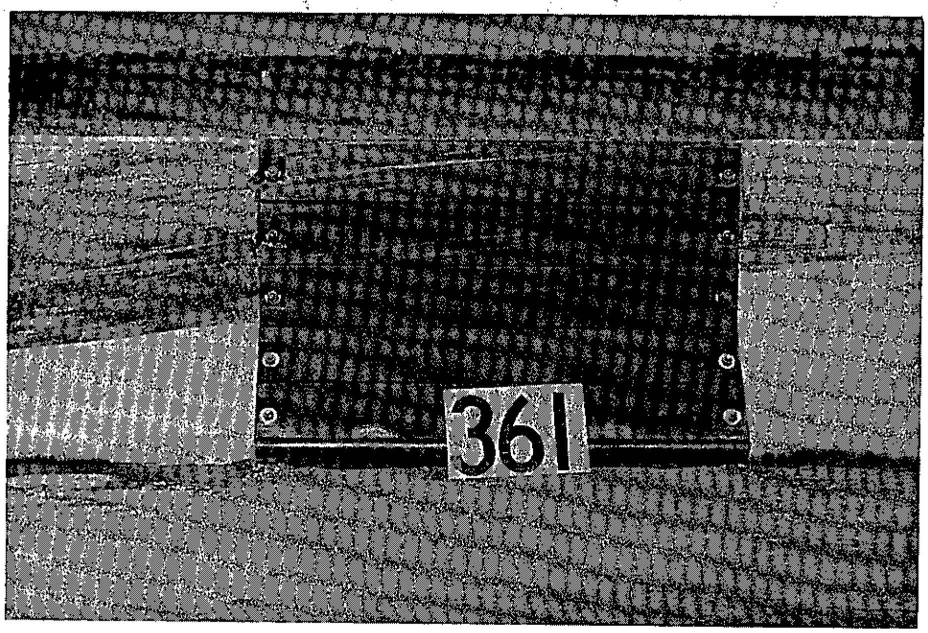


Figure 4 - Scuffs and Scrapes on Gap Beam

Concrete Barrier End Anchor Performance and Damage - The 10 foot long repoured barrier end anchor redirected the impacting vehicle. During the test the vehicle did not penetrate or vault over the barrier.

There was no permanent lateral barrier movement as a result of the test. A dynamic deflection at the top of the barrier of approximately 1/2 inch was noted, with the use of high speed photography, at the upstream connection of the gap beam to the barrier.

The barrier did not crack or sustain any structural damage during the test. Beginning at the point of impact the barrier was scuffed and scraped for about 14.5 feet as shown in Figure 5. There was some minor concrete spalling at the connection of the gap beams to the barrier, as shown in Figure 6. There was no change in the size of existing shrinkage cracks in the barrier.

Vehicle Damage - The left front quarter panel and front bumper were crushed and pushed toward the right side of the vehicle as shown in Figures 7 and 8. The left side of the radiator was pushed back toward the fan and the windshield was cracked on the left side of the vehicle. The left front tire was flat and the rim was scraped and bent. The right front quarter panel was buckled above the tire.

The floor of the vehicle in the vicinity of the brake pedal was slightly pushed up into the vehicle compartment. The left front inside door panel was dented in different areas from the impact by the dummy. There was no intrusion of barrier or vehicle components into the passenger compartment.

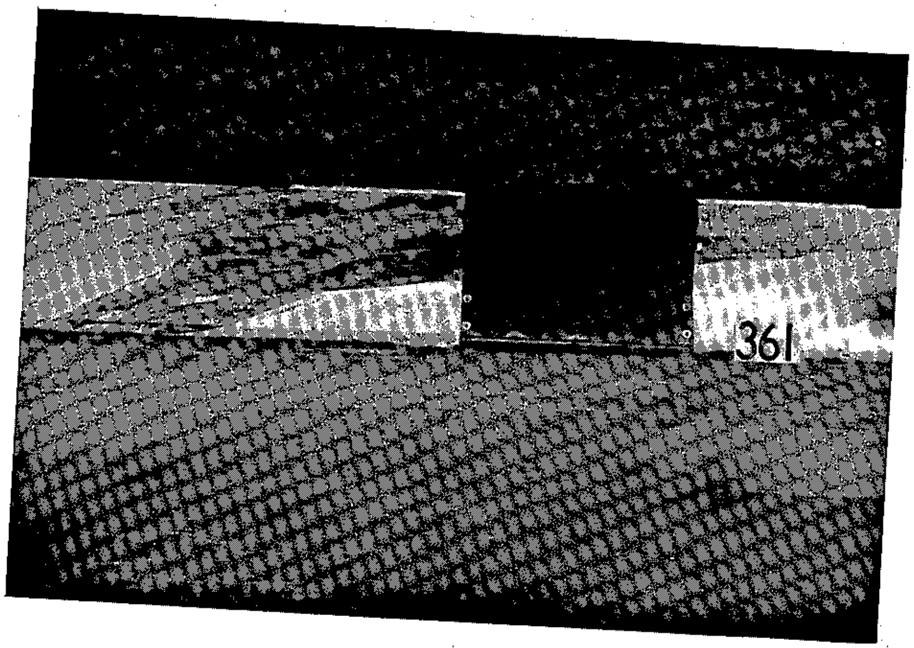


Figure 5 - Scuffs and Scrapes on Barrier

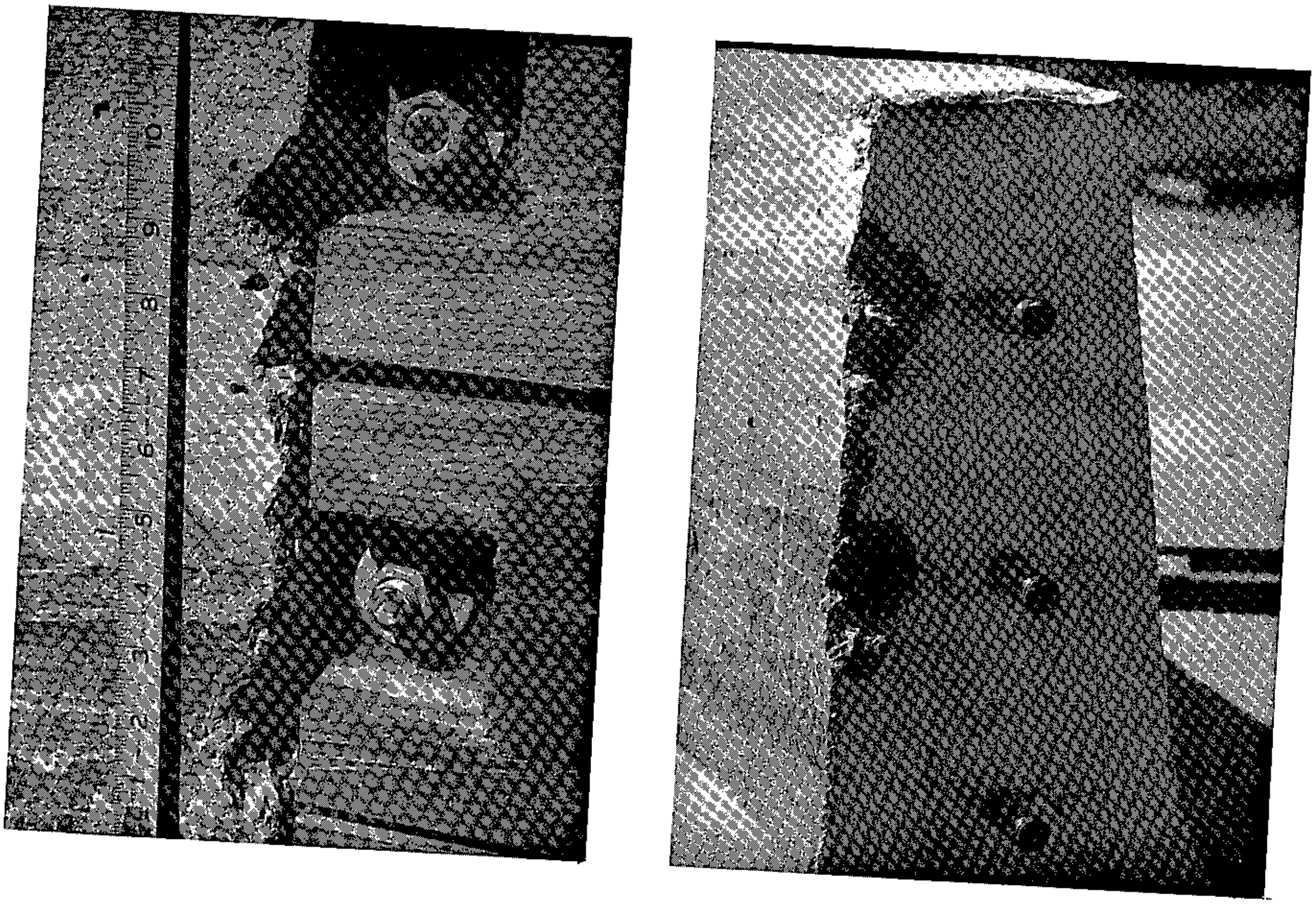


Figure 6 - Minor Concrete Spalling

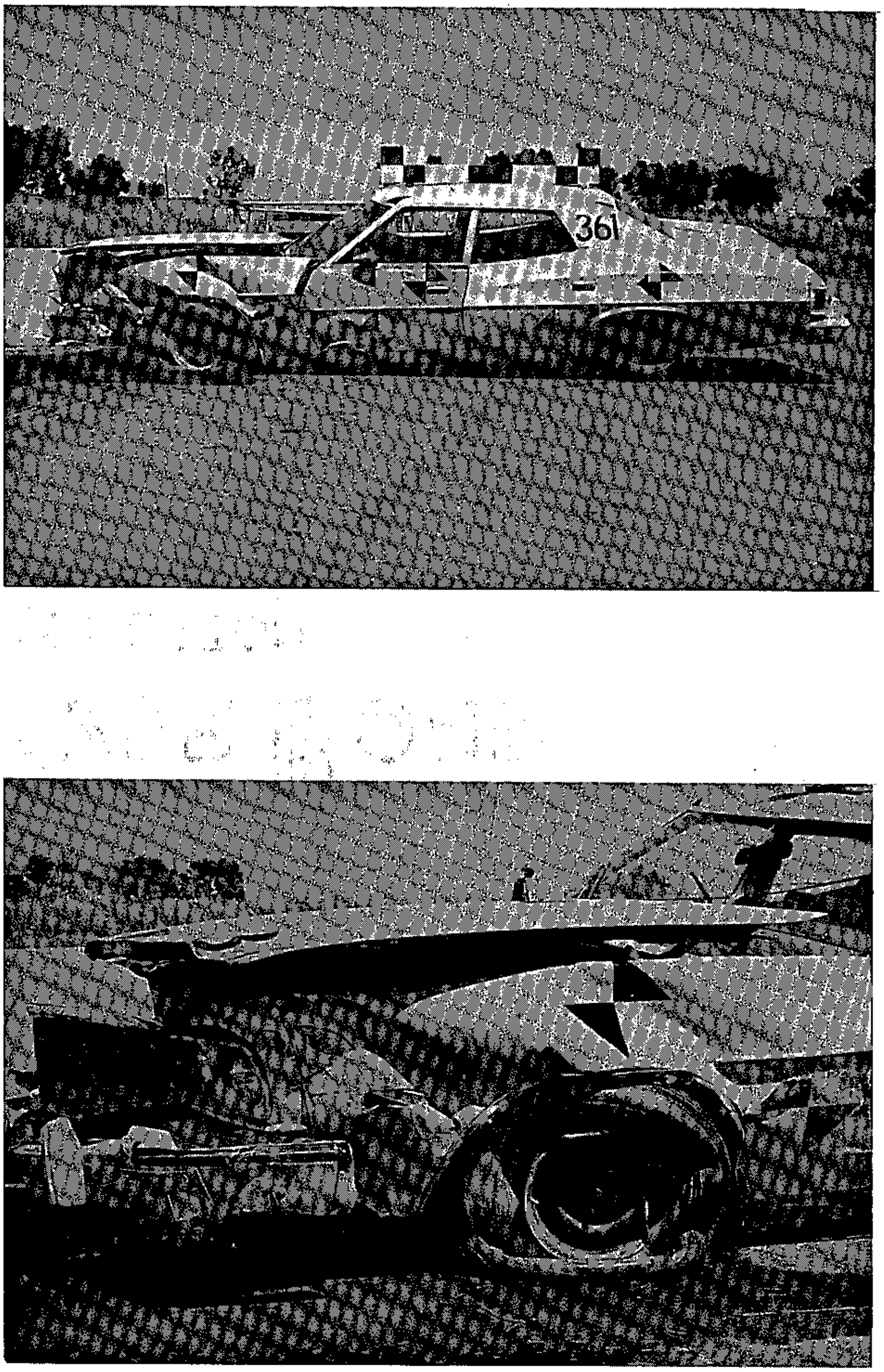


Figure 7 - Vehicle Damage

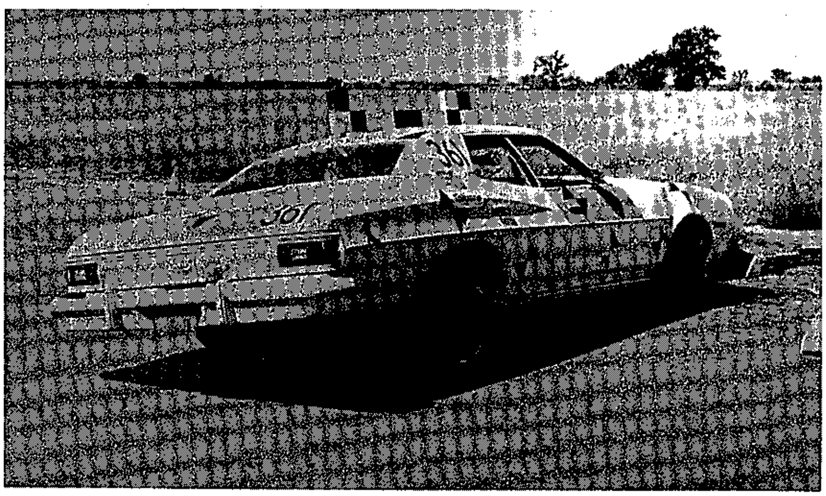
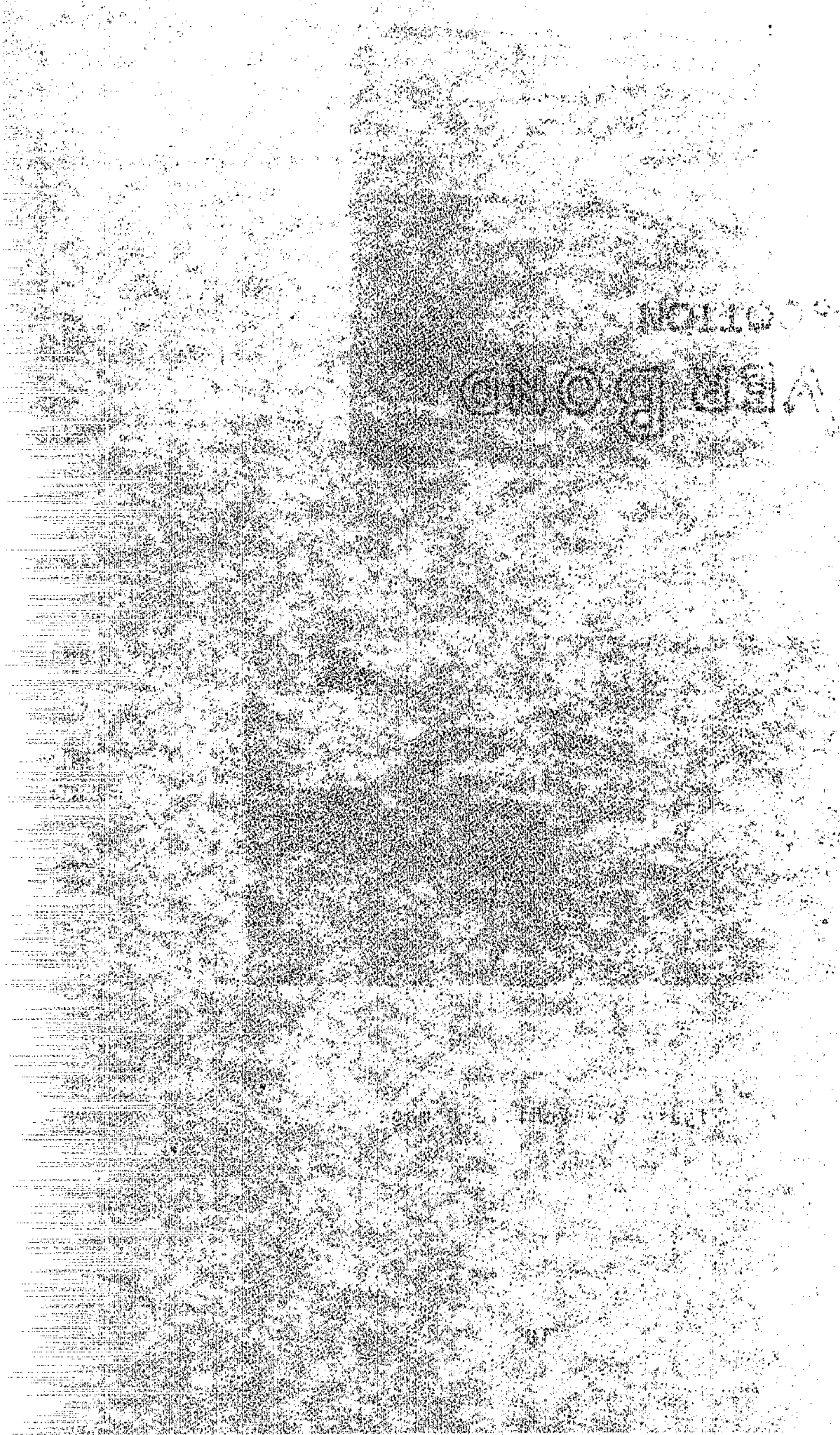


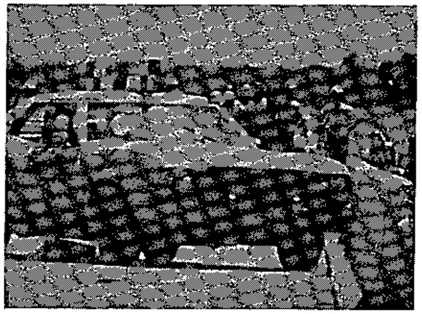
Figure 8 - Vehicle Damage



The right front molding strip and a 6 inch piece of the undercarriage were found 39 and 114 feet from the end of the barrier and 2 and 3 feet away from the front edge of the barrier, respectively.

Assessment of vehicle damage according to the Trafic Accident Scale (TAD)(4) and the Vehicle Damage Index (VDI)(5) was as follows:

TAD: LFQ-5, LD-3
VDI: 10LFEW4



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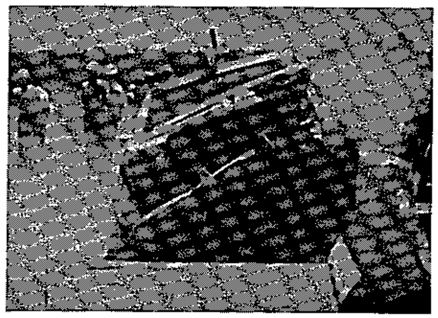

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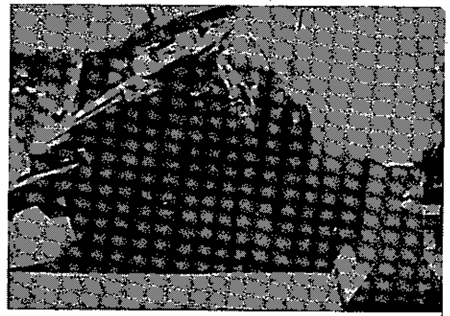

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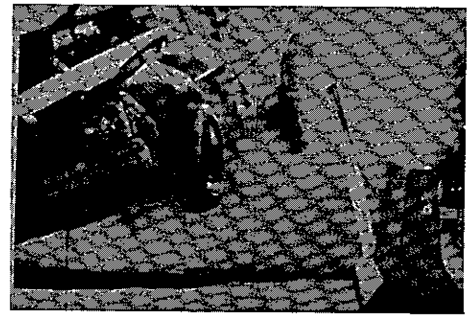

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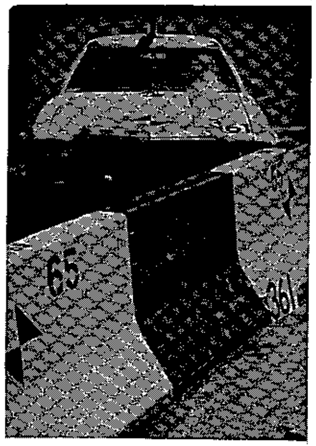
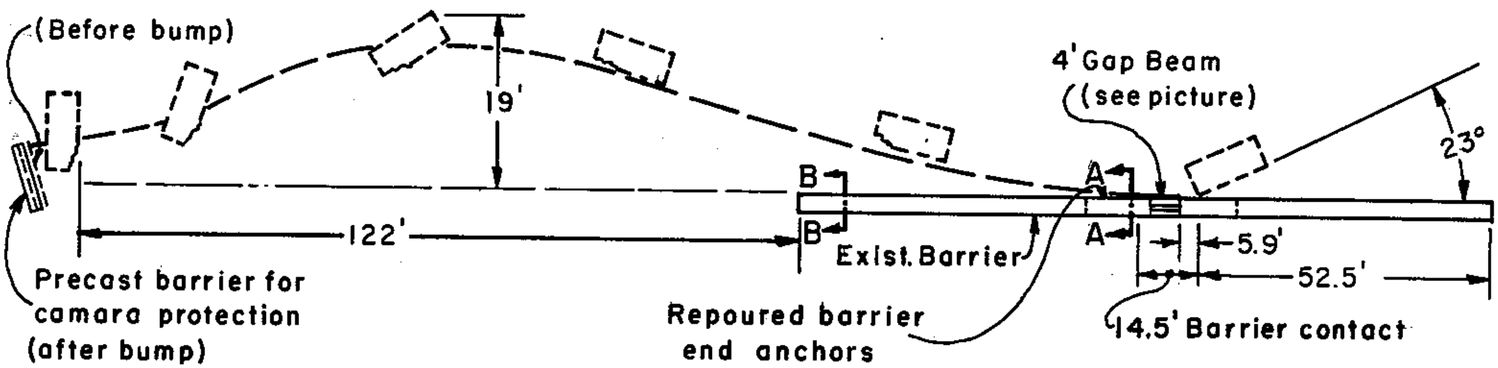
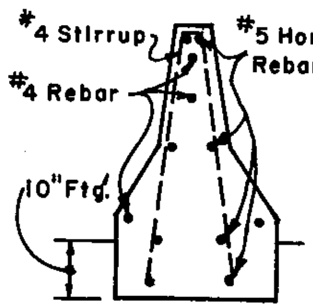
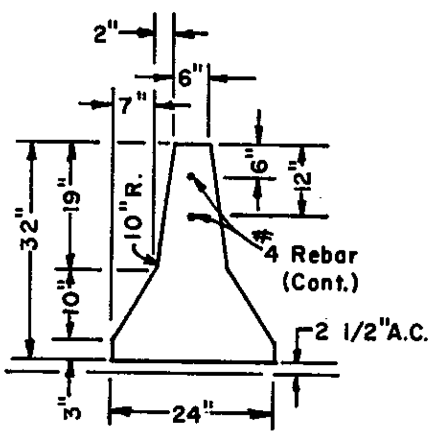


GAP BEAM





SECTION A-A



SECTION B-B

BARRIER. . . . . . . .CMB WITH GAP BEAM
LENGTH OF BARRIER. . . . . . . .120 FT.
MAX. PERMANENT LAT. DEFL. . . . 0.25 IN.
(SECOND BEAM FROM TOP)
MAX. DYNAMIC LAT. DEFL. . . . . . .0.50 IN.
MAX. VEHICLE RISE/ROLL . . . .3.5 ft./22°
LAT. K.E. = $(1/2)M(V \sin\theta)^2$. . .84 FT.-KIPS
VEHICLE DECELERATION (MAX. 50 MS AVG.)
LATERAL . . . . .9.9 g's
LONGITUDINAL . . . . .4.4 g's
VERTICAL . . . . .4.6 g's

TEST NO. 361
DATE 8/16/78
VEHICLE . . . 1974 FORD GRAN TORINO
VEHICLE WEIGHT . . . . . .4410 LBS.
(WITH DUMMY & INSTRUMENTATION)
IMPACT SPEED . . . . 61 MPH
IMPACT ANGLE . . . . .23°
VEHICLE DAMAGE: TAD LFQ-5, LD-3
VDI 10LFEW4
DUMMY RESTRAINT. . LAP & SHLDR. BELT

METRIC CONVERSIONS

1 in. = 25.4 mm 1 ft. = 0.305 m 1 ft.-k = 1.36 kJ
1 deg. = 0.0175 rad. 1 Lb. = 0.454 kg. 1 mph = 0.447 m/s

FIGURE 9, DATA SUMMARY SHEET

Discussion of Results

The gap beam was designed to follow the same shape as existing New Jersey Type 50 CMB, commonly used in California. Test 361 was conducted to find out whether this gap beam design was capable of withstanding vehicular impacts as severe as those for which the CMB is designed. The gap beam was therefore tested as part of a CMB. Safety performance of this gap beam design can be judged by comparison with three appraisal factors which are defined in Transportation Research Circular (TRC) 191, "Recommended Procedures for Vehicle Crash Testing of Highway Appurtenances" (6). The factors are: structural adequacy, impact severity, and vehicle trajectory; they are discussed in the following three sections of this report.

Table 1 summarizes data from other tests on CMB and can also be used on a relative basis for judging the results of Test 361.

Structural Adequacy - The gap beam design checked in Test 361 met Parts A and B of the TRC Report 191(6) criteria on structural adequacy:

"A. The test article shall redirect the vehicle; hence, the vehicle shall not penetrate or vault over the installation."

"B. The test article shall not pocket or snag the vehicle causing abrupt deceleration or spinout or shall not cause the vehicle to roll over. The vehicle shall remain upright during and after impact although moderate roll and pitching is acceptable. The integrity of

TABLE* I, DATA SUMMARY OF LARGE ANGLE PASSENGER VEHICLE AND HEAVY VEHICLE CMB CRASH TESTS

TEST NO.	REF.	BARRIER (8)	LENGTH ft.	FOOTING, ANCHORAGE	VEHICLE TEST PARAMETERS: YEAR & MAKE	WEIGHT lbs.	SPEED mph	IMPACT ANGLE°	KINETIC ENERGY 1000 ft-lb	LATERAL (23) KINETIC ENERGY 1000 ft-lb	VEHICLE (9) DECELERATION G's: LONG.	LAT.	VEHICLE TRAJECTORY: EXIT (13) ANGLE°	RISE (14) ft.	ROLL (16) degrees	EXIT (19) Speed mph	BARRIER CONTACT ft.	AIRBORNE DISTANCE ft.	MAX. (22) REBOUND ft.	MAX. PERM. LATERAL DEFLECTION IN	REMARKS
162		Unreinforced Concrete	160	24" x 10" Deep Concrete Footing	1965 Dodge Polara	4540	63	25	602	108	NA	NA	16	NA	25	51	12.5	20	47	Ø	Vehicle redirected
262	(1) (2) CALIF.	Prestressed Type 50 4-1/2" ϕ Strands @ 28 kips each	150	NONE	1970 Mercury Monterey	4960	59	25	577	103	7.0	11.6	NA	2.8	28	57	13	50	43	Ø	Vehicle redirected, but rolled
263		Prestressed Type 50 4-1/2" ϕ Strands @ 28 kips each	150	NONE	1970 Mercury Monterey	4960	66	25	722	129	NA	NA	8	2.7	35	55	14	55	51	Ø	Vehicle redirected, but rolled; torsional fracture in barrier.
264		Prestressed Type 50 3 of 4-1/2" ϕ Strands @ 28 kips each; 1 @ 0 kips	150	NONE	1969 Dodge Polara	4860	64	25	665	119	5.2	13.0	5	3.0	43	54	15	20	52	Ø	Vehicle redirected
265		Prestressed Type 50 4-1/2" ϕ Strands @ 10 kips each	150	NONE	1968 Dodge Polara	4780	62	24	614	102	NA	NA	4	3.7	40	52	13	30	42	Ø	Vehicle redirected; hairline fracture
CMB-1	(3) (4) T.T.I.	Reinforced Concrete 8-#5 rebars	50	3-18" diameter CIDH Concrete Shafts	1963 Plymouth	4000	62.4	25	521	93	[10] 8.7/3.2	[10] 16.1/4.4	7.3	NA	NA	NA	NA	NA	NA	Ø	Vehicle redirected
CMB-2			150	1" layer of asphalt concrete at front & back face of barrier	1964 Chevrolet	4230	55.7	25	439	78	[10] 10.3/1.8	[10] 13.3/2.8	6	NA	NA	NA	NA	NA	NA	Ø	Vehicle redirected
CMB-5					Tractor-trailer Truck	48,800 includes 22,800 ballast	34.9	19.1	1986	213	NA	NA	NA	0.7/1.3[15]	7[17]	NA	150[20]	Ø	NA	Ø	Vehicle redirected
CMB-6							33.8	15.5	1863	133	NA	NA	NA	0.7/1.6[15]	6[17]	NA	150[20]	Ø	NA	Ø	Vehicle redirected
CMB-7							44.7	15	3258	218	NA	NA	NA	1/1.6[15]	17[17]	NA	150[20]	Ø	NA	Ø	Vehicle redirected
301	(5) CALIF.	Reinforced Concrete 1-#4 rebar Slipformed Type 50 Over Lowered Cable Barrier	97	H2 1/4 x 4.1 steel posts @ 8'-0" spacing 1'-0" above grade; 3/4" cable attached to posts; turnbuckle w/anchor rod embedded in concrete end anchors.	1969 Dodge Polara	4860	68	27	751	155	11.7	13.8	7	3.2	27	50	13.1	30	31	0.08	Vehicle redirected
MI-ISC 01/319	(6) FRANCE	Reinforced Concrete 2-#4 rebars	> 160	NONE	404 Peugeot	2745	52	31	248	66	>10[11]	16[11]	Small	NA	NA	NA	8.5	Slightly	NA	Ø	Vehicle redirected
TS-ISC 02/320		(Same location as Calif. Test 321)			Truck Bernard Type 19 DA150	21,650	44.7	21	1446	186	7.5[11]	11.5[11]	Small	NA	NA	NA	59	Some	NA	Ø	Vehicle redirected 8" x 9' section of barrier top broke out
CMB-21	(7) SWRI	Reinforced Concrete 1-#4 rebar	200 With const. joints 50 ft. from each end	1" layer of asphalt concrete placed at base of barrier on the side opposite impact	1955 GMC Scenicruiser Bus Model PD-4501	40,000 With 10,200 ballast	41.7	11.5	2324	92	0.9[12]	0.7[12]	Small	NA	8[18]	NA	25.9	Ø	NA	Ø	Vehicle redirected
CMB-22							51.6	6.6	3559	47	0.9[12]	0.8[12]	Small	NA	9[18]	NA	28	Ø[21]	NA	Ø	Vehicle redirected
CMB-23							52.9	16	3741	284	0.8[12]	1.0[12]	Small	NA	24[18]	NA	65	Ø	NA	31	Vehicle redirected; extensive barrier damage
321	CALIF. (26)	Reinforced Concrete 2-#4 rebars	120	NONE	1973 Dodge Polara	4700	61	26	584	112	—	—	7	5.5[24]	48	45	16	5	23	Ø	Vehicle redirected but rolled
361	CALIF.	Reinforced concrete, 2-#4 rebars with steel Channel beams spanning a 4 ft. gap at midlength (25)	120	24" x 10" Deep concrete footing extends 10' on each side of gap.	1974 Ford Grand Torino	4410	61	23	548	84	4.4[12]	9.9[12]	7	3.5[24]	22	50	14.5	Ø	19	Ø	Vehicle redirected

* Footnotes on following page

TABLE 1, continued

DATA SUMMARY OF LARGE ANGLE PASSENGER VEHICLE AND HEAVY VEHICLE CMB CRASH TESTS

Footnotes for Table 1

(1) California Division of Highways, report reference 7.

(2) California Division of Highways, report reference 8.

(3) Texas Transportation Institute, report reference 9.

(4) Texas Transportation Institute, report reference 10.

(5) California Department of Transportation, report reference 11.

(6) National Institute for Road Safety, report reference 12.

(7) Southwest Research Institute, report reference 3.

(8) All have the New Jersey median barrier cross section except CMB-1, CMB-2, CMB-5, CMB-6 and CMB-7 which are 2" wider at the top and 3" wider at the bottom.

(9) Maximum 50 millisecond accelerometer averages except for CMB-1, CMB-2, CMB-21, CMB-22, CMB-23, MI-ISC 01/319 and TS-ISC 02/320.

(10) Maximum/average deceleration values

(11) Peak deceleration values.

(12) Maximum 50 millisecond averages obtained from high speed film analysis

(13) Direction of travel of vehicle c.g. immediately following final contact with barrier.

(14) Maximum height above ground of the left front wheel unless noted.

(15) Rise of center of front bumper/rise of center of mass of truck cab.

(16) Maximum rotation about the longitudinal axis of the vehicle away from the face of the barrier unless noted.

(17) Trailer roll only.

(18) Roll toward barrier.

(19) Velocity of vehicle c.g. immediately following final contact with barrier.

(20) Front wheels locked in straight ahead steering position prior to impact.

(21) Right front tire airborne for 0.3 seconds.

(22) Maximum lateral distance of vehicle travel (includes width of vehicle) from face of barrier after impact.

(23) $\frac{m(V \sin \Theta)^2}{2}$

(24) Maximum rise above ground of left rear quarter panel of vehicle.

(25) 10' Section each side of gap contains 4 continuous #4 rebar, 8-#5 x 5' longitudinal rebar and 4-#4 stirrups @ 9" o/c, starting at the face of the concrete at each end of the gap.

(26) California Department of Transportation, report reference 2.

Metric Conversions

1 in. = 25.4 mm	1 lb = 0.454 kg	1 ft.-lb = 1.36 J
1 ft. = 0.305 m	1 deg = 0.0175 rad.	1 mph = 0.447 m/s

passenger compartment must be maintained. There shall be no loose elements, fragments, or other debris that could penetrate the passenger compartment or present undue hazard to other traffic."

The two top channel beams in the barrier bowed in slightly but it would not be necessary to replace them because the damage was so slight. Other than removing or painting over the scuff marks on the face of the gap beam, little maintenance would be required.

The concrete barrier end anchor segments also met Parts A and B of TRC Report 191(6) criteria on structural adequacy. As in the case of the gap beam, the only maintenance required would be to remove or paint over the scuff marks on the face of the barrier. The scrapes and gouges in the face of the barrier could be neglected.

In comparison with other tests in Table 1, the results of Test 361 are representative of tests with similar impact conditions.

The main objective of Test 361 was to check the structural strength and stability of the gap beam design in a continuous CMB. This test proved that the gap beam design could withstand severe vehicular impacts with a heavy passenger vehicle.

Impact Severity - In TRC Report 191(6), the impact severity criteria for longitudinal barriers apply only to vehicle impact angles of 15 degrees or less. These criteria refer to vehicular deceleration values. The recommended deceleration limits are as follows:

"A. Where test article functions by redirecting vehicle, maximum vehicle acceleration measured near the center of mass should be less than the following values:

Maximum Vehicle Accelerations (g's)			
Lateral	Longitudinal	Total	Remarks
3	5	6	Preferred
5	10	12	Acceptable"

The "preferred" levels assume no seat belt restraints and the "acceptable" levels assume lap belt restraints but no shoulder belt restraints. In our test a lap and shoulder belt were used.

Accelerometers were mounted in the test vehicle and as a point of interest the deceleration levels for the 23 degree angle impact in Test 361 can be compared with the above table. The maximum 50 millisecond (ms) average lateral deceleration was 9.9 g's and the longitudinal deceleration was 4.4 g's. The test vehicle contained two accelerometers in the longitudinal direction: the 4.4 g's value is the average of the two. The longitudinal readings were in the "preferred" range, but the lateral reading was above the upper limit of the "acceptable" range, as expected for this severe impact test. There was also an accelerometer mounted in the vertical direc-ion. The maximum 50 ms average deceleration reading for it was 4.6 g's.

These deceleration values are comparable to those for similar tests in Table 1. The vehicle acceleration versus time traces for Test 361 are contained in the Appendix, Figure 8A.

Use of a dummy is considered optional in the TRC Report 191(6). An anthropomorphic dummy was used in Test 361, and the electronic data from accelerometers mounted in the dummy's head are further indications of impact severity. Acceleration versus time traces for these accelerometers are included in the Appendix, Figure 9A.

Vehicle Trajectory Hazard - The TRC report states:

"A. After impact, the vehicle trajectory and final stopping position shall intrude a minimum distance into adjacent traffic lanes."

The report adds, "A subjective appraisal shall be made by the test engineer as to the trajectory hazard, based on vehicle exit speed and angle, maximum intrusion into a traffic lane or lanes during trajectory, and post crash controllability."

The final resting position of the test vehicle after impact is shown on the Data Summary Sheet, Figure 9, in the Test Results section of the report and in Figure 10.

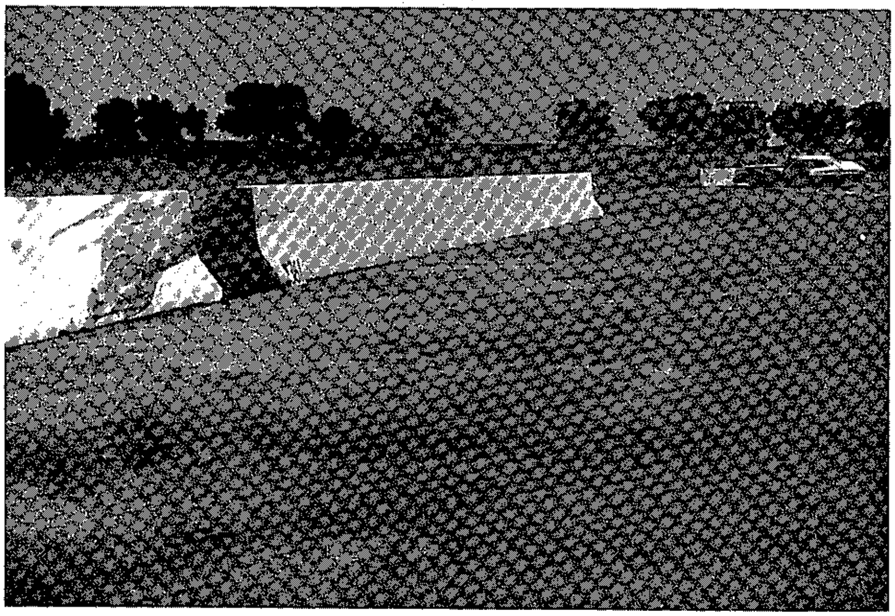


Figure 10 - Final Resting Position of Vehicle

The maximum rebound distance for the vehicle along its post-impact trajectory was about 19 feet from the impact side of the barrier. Assuming an 8 foot shoulder width next to the CMB and 12 foot traffic lanes, the test vehicle could have interfered with traffic in the lane closest to the barrier. The vehicle exited the barrier at about 7 degrees at a speed of about 50 mph. There was some flying debris from the vehicle but it probably would not have been hazardous to other vehicles due to its trajectory.

Other than the rebound of the vehicle, the post-impact trajectory was quite good, considering the severe conditions of impact. The vehicle did not roll over or spin out in an erratic manner, but coasted directly to a stop at a point along the line of the barrier, thus minimizing the amount of maneuvering that would have been necessary by following vehicles. The rear end of the vehicle at rest may have protruded into the closest traffic lane.

The trajectory of the test vehicle would have been slightly modified had the vehicle not bumped the precast barrier section protecting the cameras. If the test barrier had been continuous, the vehicle would have bumped it, and probably would have changed the final resting place of the test vehicle.

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2. Parks, D. M., et al, "Vehicular Crash Test of a Continuous Concrete Median Barrier Without a Footing", Report No. FHWA-CA-TL-6883-77-22, California Department of Transportation, June 1977.

3. Bronstad, M. E., L. R. Calcote, and C. E. Kimball, Jr., "Concrete Median Barrier Research", Volume 2 Research Report, Report No., FHWA-RD-77-4, Southwest Research Institute, March 1976.

4. "Vehicle Damage Scale for Traffic Accident Investigators", Traffic Accident Data Project Bulletin No. 1, National Safety Council, 1968.

5. "Collision Deformation Classification, Recommended Practice J224a", 1973 Handbook, Society of Automotive Engineers, New York, 1973.

6. Transportation Research Board, "Recommended Procedures for Vehicle Crash Testing of Highway Appurtenances", Transportation Research Circular 191, February 1978.

7. Nordlin, E. F., R. N. Field, and J. R. Stoker, "Dynamic Tests of Concrete Median Barrier, Series XVI", Report No. 636392-2, California Division of Highways, August 1967 (or Highway Research Record 222, 1968, pp 53-89).

8. Nordlin, E. F., et al, "Dynamic Tests of Prestressed Concrete Median Barrier Type 50, Series XXVI", Report No. CA-HY-MR-6588-1-73-06, California Division of Highways, March 1973.

9. Post, E. R., et al, "Vehicle Crash Test and Evaluation of Median Barriers for Texas Highways", Highway Research Record 460, 1973, pp 97-113.

10. Post, E. R., T. J. Hirsch, and J. F. Nixon, "Truck Tests on Texas Concrete Median Barrier", Highway Research Record 460, 1973, pp 73-81.

11. Nordlin, E. F., et al, "Dynamic Test of a Slipformed Concrete Barrier Type 50 Placed Over Existing Cable Barrier", Report No. CA-DOT-TL-6696-1-74-36, California Department of Transportation, December 1974.

12. "Separateur Central", National Institute for Road Safety, La Verriere, France, 1974, pp 319-1 thru 5 and 320-1 thru 4.

APPENDIX

Test Vehicle Equipment and Guidance System

Vehicle modifications and the guidance system used for the test are itemized as follows:

1. The test vehicle gas tank was disconnected from the fuel supply line and drained. Shortly before the test, dry ice was placed in the tank to drive out oxygen and any remaining fumes, and thus minimizing the conditions needed to support combustion. A one-gallon safety gas tank was installed in the trunk compartment and connected to the fuel supply line.

2. Two 12-volt wet cell motorcycle-type batteries were mounted in the trunk to supply power for the remote control equipment.

3. A solenoid-valve actuated CO_2 system was used for remote braking, Figure 1A. Part of this system was a cylinder with a piston, which was attached to the brake pedal, Figure 2A. The pressure used to operate the piston was regulated according to the test vehicle's weight, to stop the test vehicle without locking up the wheels.

4. The ignition system was connected to the brake relay in a failsafe interlock system. When the brake system was activated, the vehicle ignition was switched off.

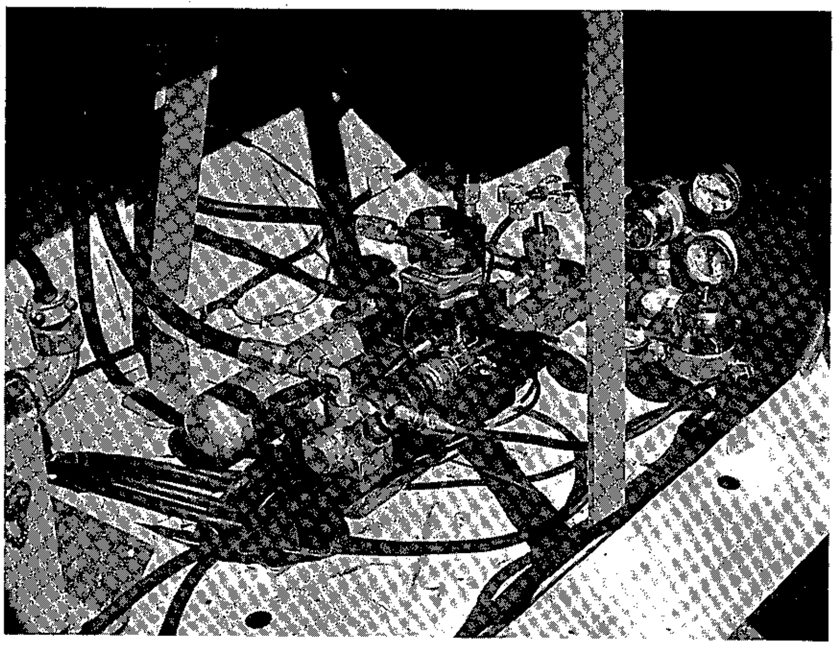


Figure 1A - Solenoid-valve Actuated CO_2 System

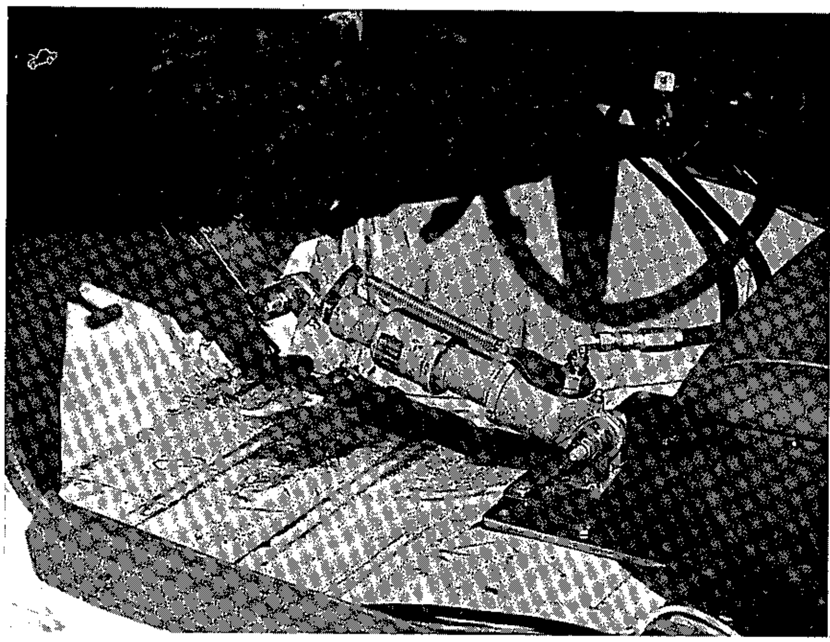


Figure 2A - Cylinder with Piston for Braking

5. A micro switch was mounted below the front bumper and connected to the ignition system. A trip plate placed on the ground near impact triggered the switch when the car passed over it, thus opening the ignition circuit and cutting the vehicle engine prior to impact.

6. The accelerator pedal was linked to a small cylinder with a piston which, when activated, opened the throttle. The piston was activated by a manually thrown switch mounted on the top of the rear fender of the test vehicle. The piston was connected to the same CO_2 tube used for the brake system, but a separate regulator was used to control the pressure.

7. A cable guidance system was used to direct the vehicle into the barrier. The guidance cable, anchored at each end of the vehicle path, passed through a slip-base guide bracket, Figure 3A, bolted to the spindle of the right front wheel of the vehicle. A steel knockoff bracket, Figure 4A, anchoring the end of the cable closest to the barrier to a concrete footing, projected high enough to knock off the guide bracket, thereby releasing the vehicle from the guidance cable prior to impact.

8. The remote brakes were controlled at the console trailer, Figure 5A, by using an instrumentation cable connected between the vehicle and the electronic instrumentation trailer, and a cable from that trailer to the console trailer. Any loss of continuity in these cables caused an automatic activation of the brakes.

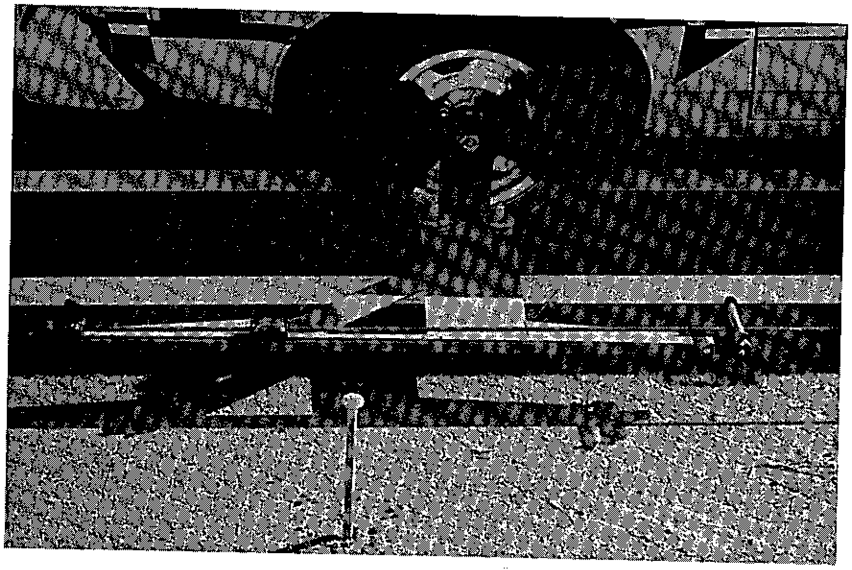


Figure 3A - Slipbase Guide Bracket

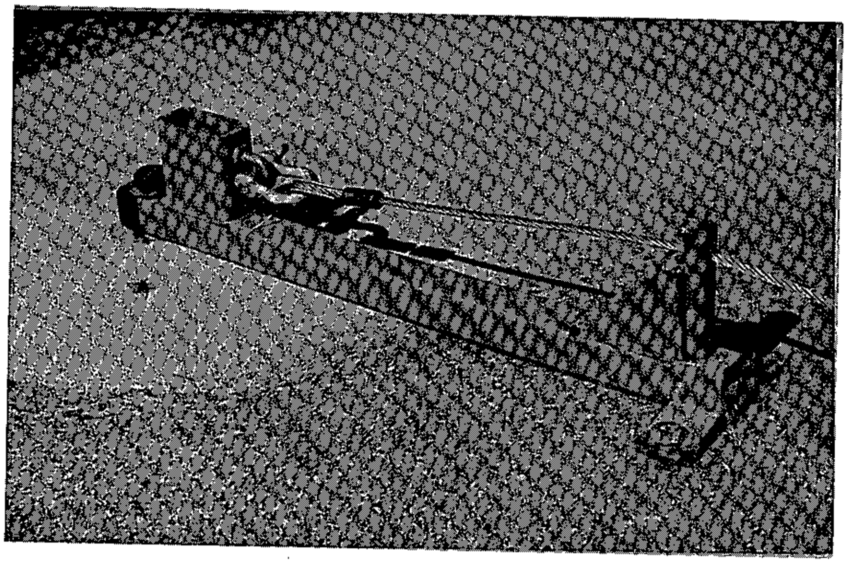
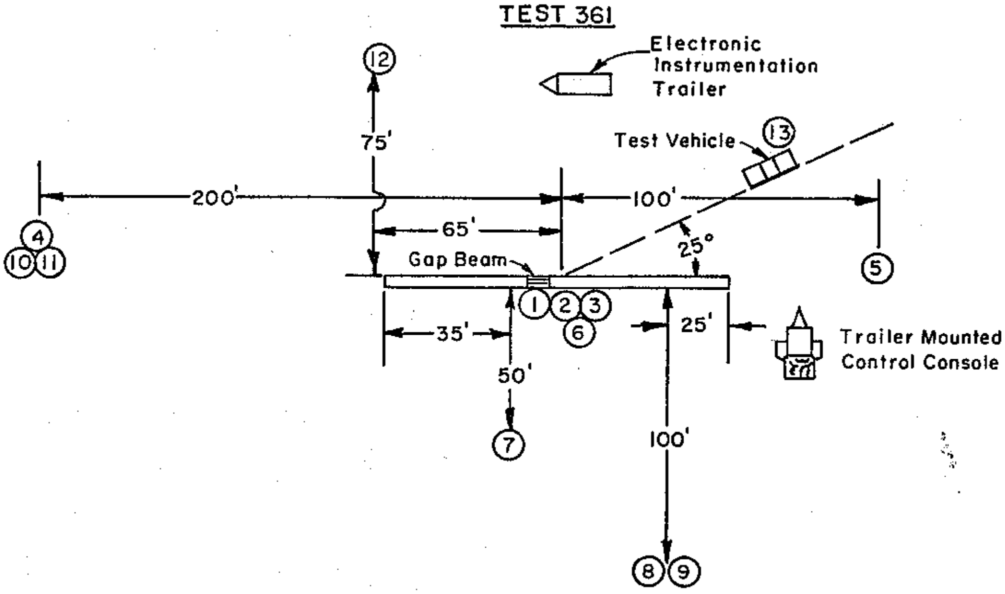


Figure 4A - Steel Knockoff Bracket

Figure 5A, CAMERA LAYOUT



CAMERA DATA[1.]

1 2 3	PHOTO·SONICS MODEL 16mm-1B, 13mm LENS, (275-350)FPS[2]; MOUNTED ON 31 FT. TOWER
4	REDLAKE LOCAM 16mm, 100mm LENS, 400 FPS.
5	REDLAKE LOCAM 16mm, 50mm LENS, 400 FPS
6	PHOTO·SONICS MODEL 16mm-1B, 2" LENS, 350 FPS
7	PHOTO·SONICS MODEL 16mm-1B, 13mm LENS, 350 FPS
8	REDLAKE LOCAM 16mm, 12/120mm LENS, 400 FPS, PAN CAMERA
9	BOLEX, 1" LENS, 24 FPS, PAN CAMERA
10	70mm HULCHER, 12" LENS, 20 FPS, SEQUENCE CAMERA
11	35mm HULCHER, 50mm LENS, 20 FPS, SEQUENCE CAMERA
12	PHOTO·SONICS MODEL 16mm-1B, 100mm LENS, 200 FPS
13	PHOTO·SONICS MODEL 16mm-1B, 5.3mm LENS, 200 FPS

1. ALL CAMERAS MOUNTED ON TRIPODS UNLESS OTHERWISE NOTED.
2. FRAMES PER SECOND

METRIC CONVERSIONS

1 in.=25.4mm; 1ft.=0.305m
1 deg.=0.0175 rad.

9. A speed control device connected between the negative side of the coil and the battery of the vehicle regulated the speed of the test vehicle based on engine revolutions per minute. This device was calibrated prior to the test by conducting a series of trial runs through a speed trap composed of two tape-switches set a known distance apart connected to a digital timer.

Photo-Instrumentation

Data film was obtained by using seven high speed Photo-Sonics Model 16 mm-1B cameras, 200-400 frames per second (fps) and three high speed Redlake Locam cameras, 400 fps. These cameras were located around the barrier as shown in Figure 5A, Camera Layout.

All cameras were electrically actuated from a central control console, Figure 5A, except for camera 12, which was actuated by a cameraman. An eighth Photo-Sonics Model 16 mm-1B camera was placed in the test vehicle to record the motions of the anthropomorphic dummy during impact. This camera was triggered by a tether line-actuated switch mounted on the rear bumper of the test vehicle.

All cameras (except for camera 12, Figure 5A) were equipped with timing light generators which exposed reddish timing pips on the film at a rate of 1000 per second. The pips were used to determine camera frame rates and to establish time-sequence relationships. Additional coverage of the impacts was obtained by a 70 mm Hulcher sequence camera and a 35 mm Hulcher sequence camera (both operating at 20 frames per second). Documentary coverage of the tests consisted of normal speed movies and still photographs taken before, during and after the impact. Data from the high-speed movies was reduced on a Vanguard Motion Analyzer, Figure 6A.

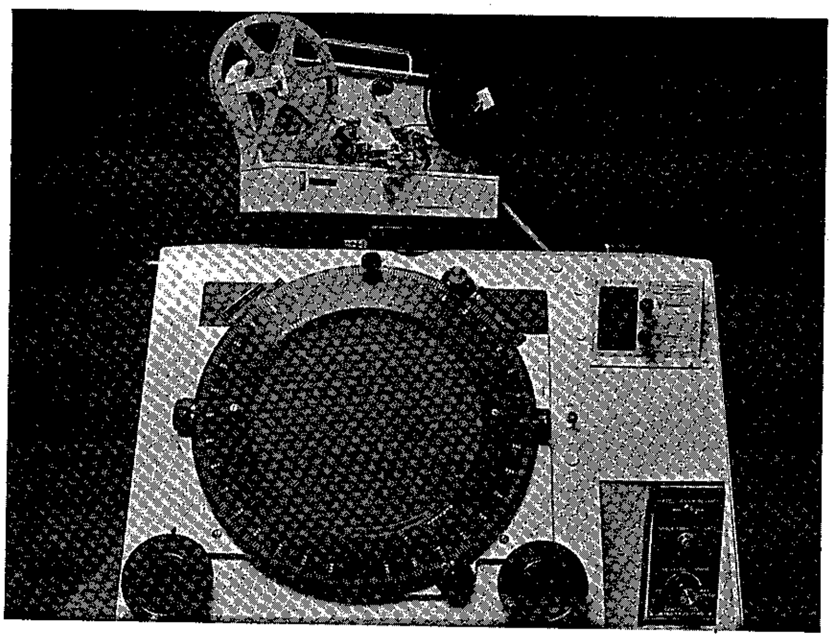


Figure 6A - Vanguard Motion Analyzer

Some procedures used to facilitate data reduction for the test are listed as follows:

1. Targets were attached to the vehicle body and to the barrier.

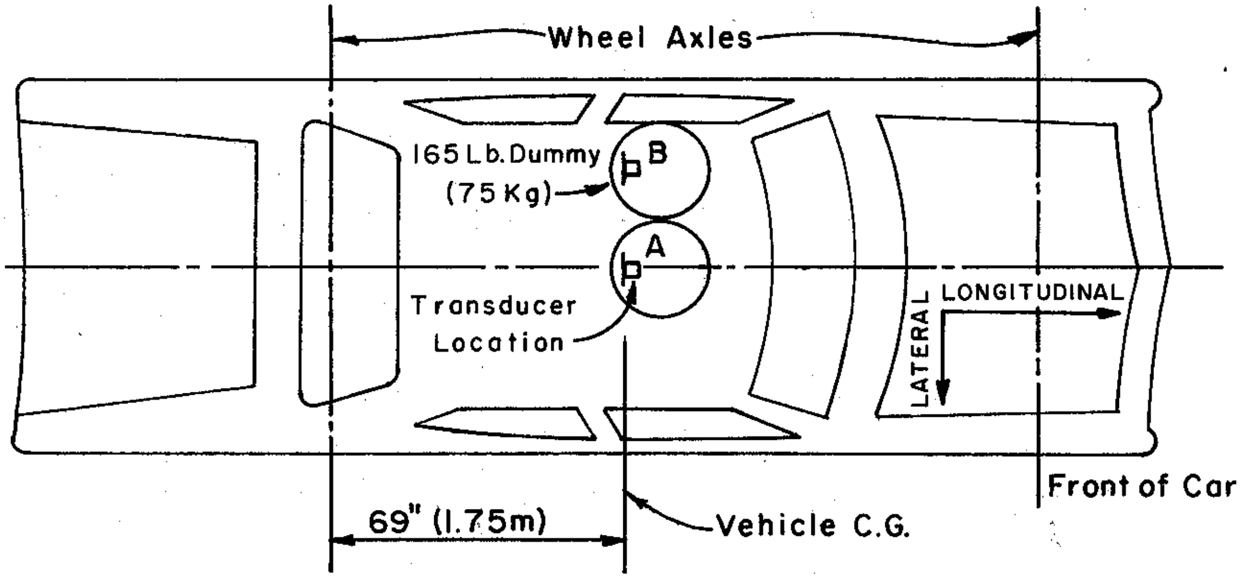
2. Flashbulbs, mounted on the test vehicle, were electronically flashed to establish (a) initial vehicle/barrier contact and (b) the application of the vehicle's brakes. The impact flashbulbs have a delay of several milliseconds before lighting up.

3. Five tape switches, placed at 10 foot intervals, were attached to the ground perpendicular to the path of the impacting vehicle beginning about 6 feet from impact. Flashbulbs were activated sequentially when the tires of the test vehicle rolled over the tape switches. The flashbulb stand was placed in view of all the data cameras and was used to correlate the cameras with the impact events.

Electronic Instrumentation and Data

Data from all transducers in the test vehicle were transmitted through a 1000 foot Belden #8776 umbilical cable connecting the vehicle to a 14-channel Hewlett Packard 3924C magnetic tape recording system. This recording system was mounted in an instrumentation trailer located in the test control area, Figure 5A. Figure 7A shows the locations of all transducers mounted in the test vehicle. A total of 7 accelerometers were used for deceleration measurements. Three Statham accelerometers, of the unbonded strain gage type, were mounted in the head cavity of the

Figure 7A, VEHICLE INSTRUMENTATION



1974 FORD GRAN TORINO, 4410 LBS. (2000 kg)

CHANNEL NO.	TRANSDUCER		LOCATION		
	TYPE	SER. NO.			
1	Accelerometer	589	B	Stan's Head (Dummy)	Longitudinal
2	"	591	B	" " "	Lateral
3		1029	B	" " "	Vertical
5	"	586	A	Car Floor	Lateral
7	"	AN92	A	" "	Longitudinal
8	"	DG66	A	" "	Vertical
9	"	6412	A	" "	Longitudinal

NOTE: Location A - is on a steel angle bracket welded to the floor at the vehicle center of gravity.

Location B - is on the inside back of the head cavity of the dummy.

anthropomorphic dummy. Two Statham and two Endevco Model 2262-200 piezoresistive accelerometers were mounted on the floorboard of the test vehicle.

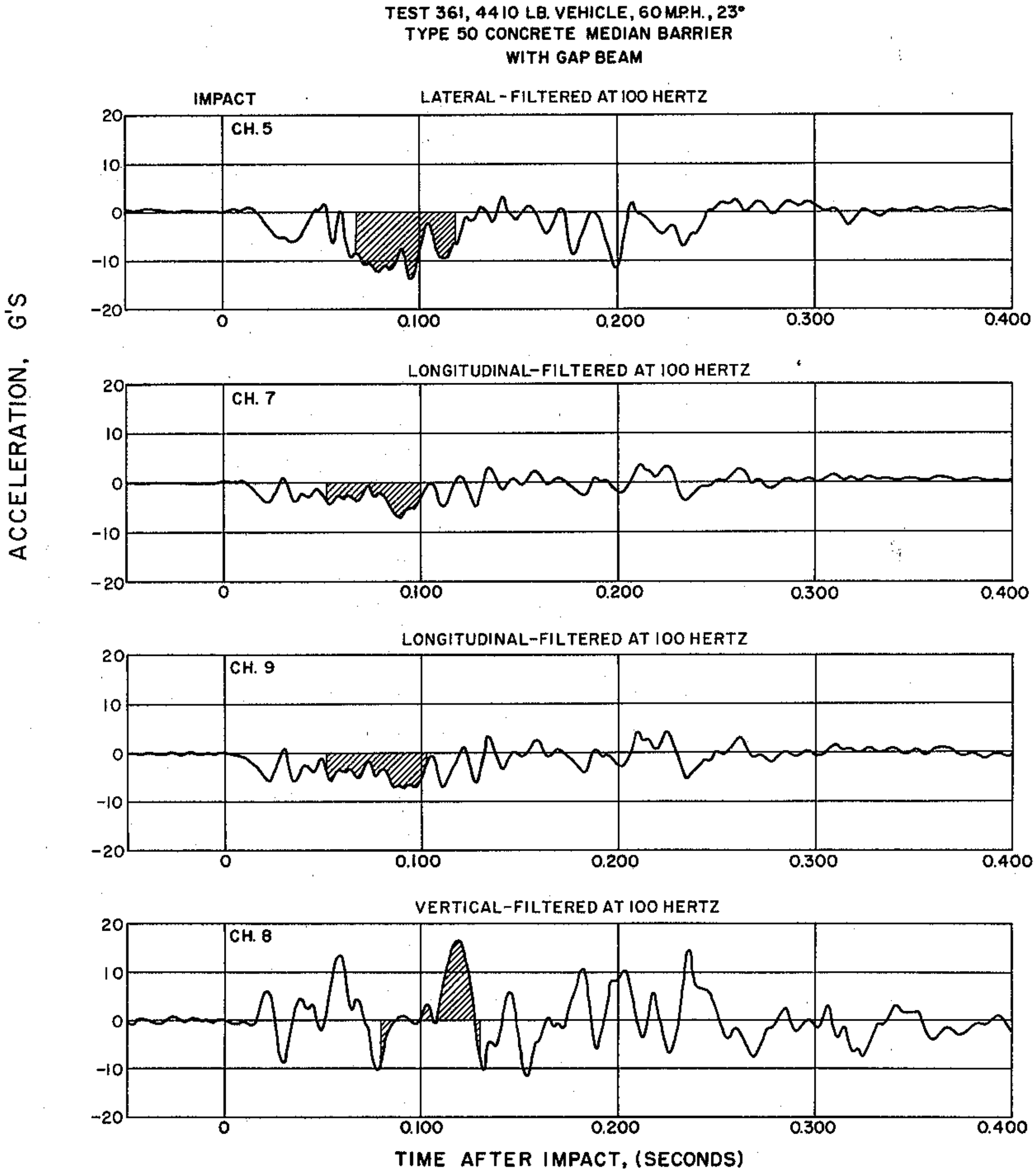
Three pressure-activated tape switches were attached to the ground beginning about 5 feet from impact and spaced at 12-foot intervals in the vehicle approach path as "event markers". When activated by the test vehicle tires, these switches produced sequential impulses which were recorded with the transducer signals on the tape recorder. A time cycle was also recorded on tape concurrently with the tape switch impulses. The impact velocity of the vehicle could be determined from these tape switch impulses and timing cycles. Two additional tape switches were placed 12 feet apart near the barrier specifically to determine impact speed of the vehicle on the test day.

After the test, the tape recorder data was played back through a Visicorder which produced an oscillographic trace (line) on paper for each channel of the tape recorder. Each paper record contained a curve of data representing one transducer, signals from the three tape switches, and the time cycle markings.

Longitudinal, lateral, and vertical vehicle acceleration records are shown in Figure 8A. Acceleration responses of the anthropomorphic dummy are shown in Figure 9A.

Some of the accelerometer data records contained high frequency spikes. All data was filtered at 100 Hertz with a Krohn-Hite filter to facilitate data reduction. The smoother resultant curves give a good representation of the overall deceleration of the vehicle without significantly altering the amplitude and time values of the deceleration pulse.

Figure 8A. VEHICLE ACCELERATION VS TIME

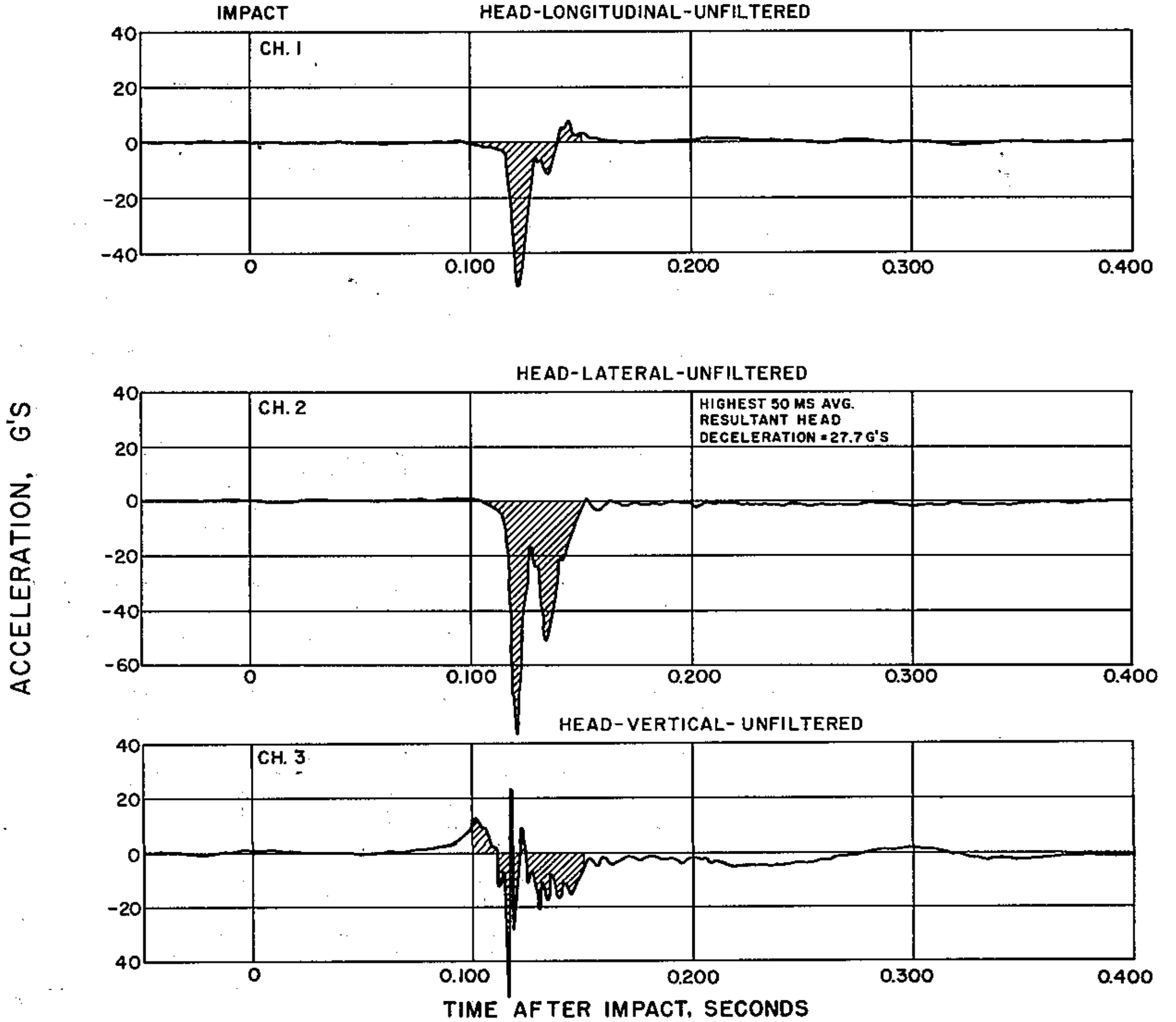


METRIC CONVERSIONS
1 lb. = 0.454 kg
1 mph = 0.447 m/s
1 deg. = 0.0175 rad.

Figure 9A, DUMMY ACCELERATION VS TIME

TEST 361, 4410 LB. VEHICLE, 60MPH, 23°
LAP AND SHOULDER BELT

TYPE 50 CONCRETE MEDIAN BARRIER
WITH GAP BEAM



METRIC CONVERSIONS

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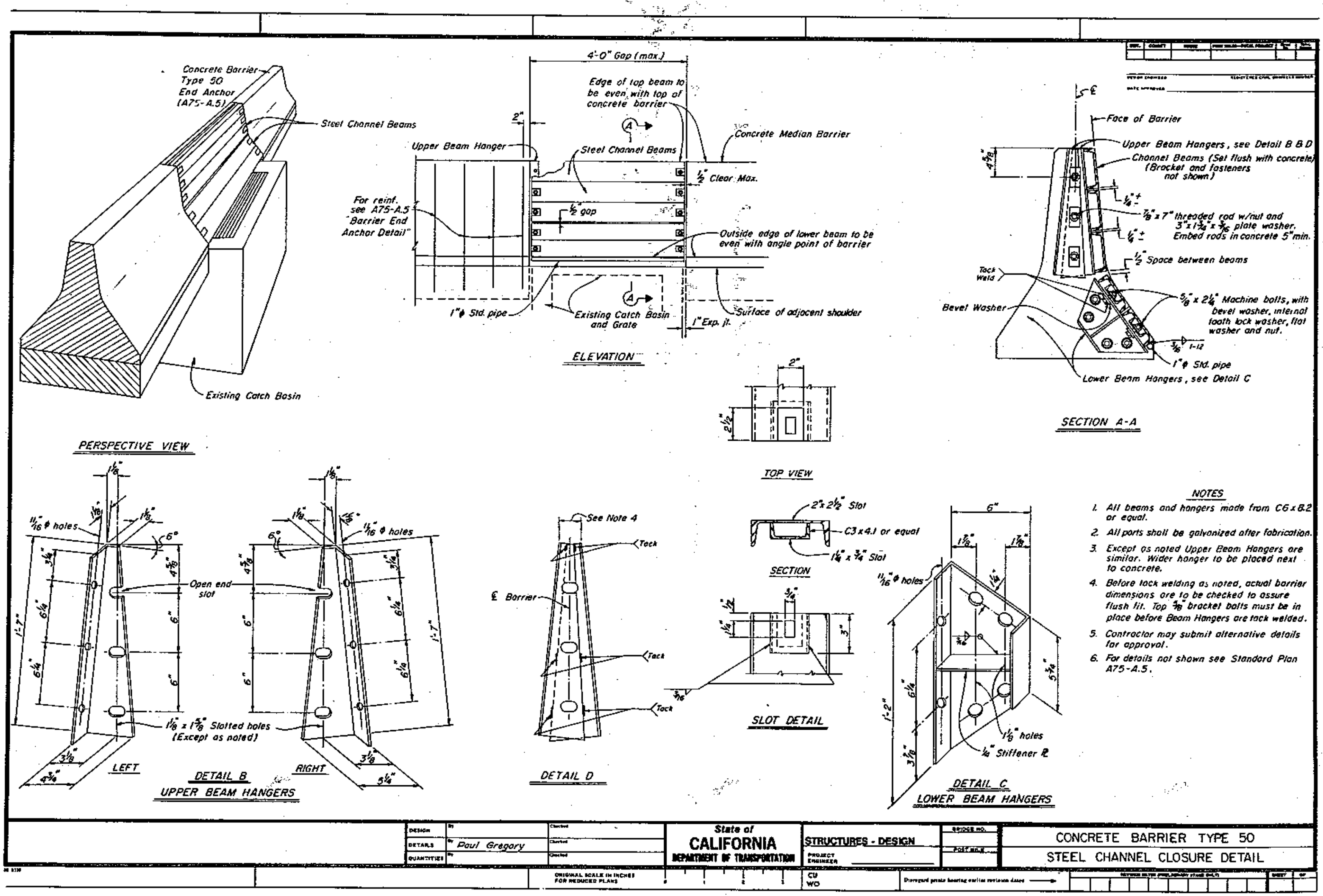

PERSPECTIVE VIEW
Concrete Barrier Type 50 End Anchor (A75-A.5)
Steel Channel Beams
Existing Catch Basin
ELEVATION
4'-0" Gap (max.)
Edge of top beam to be even with top of concrete barrier
Concrete Median Barrier
Upper Beam Hanger
Steel Channel Beams
½" Clear Max.
½" gap
For reinf. see A75-A.5 "Barrier End Anchor Detail"
Outside edge of lower beam to be even with angle point of barrier
1"φ Std. pipe
Existing Catch Basin and Grate
Surface of adjacent shoulder
1" Exp. jt.
SECTION A-A
Face of Barrier
Upper Beam Hangers, see Detail B & D
Channel Beams (Set flush with concrete) (Bracket and fasteners not shown)
⅞" x 7" threaded rod w/nut and 3" x 1¾" x ⁵⁄₁₆ plate washer. Embed rods in concrete 5" min.
½" Space between beams
Tack Weld
Bevel Washer
⅝" x 2¼" Machine bolts, with bevel washer, internal tooth lock washer, flat washer and nut.
1" φ Std. pipe
Lower Beam Hangers, see Detail C
TOP VIEW
SECTION
2" x 2½" Slot
C3 x 4.1 or equal
1¼" x ¾" Slot
SLOT DETAIL
DETAIL B
UPPER BEAM HANGERS
LEFT
RIGHT
Open end slot
¹¹⁄₁₆" φ holes
1⅛" x 1⅝" Slotted holes (Except as noted)
DETAIL D
See Note 4
Tack
℄ Barrier
DETAIL C
LOWER BEAM HANGERS
¹¹⁄₁₆" φ holes
1⅛" holes
¼" Stiffener ℙ
NOTES
1. All beams and hangers made from C6 x 8.2 or equal.
2. All parts shall be galvanized after fabrication.
3. Except as noted Upper Beam Hangers are similar. Wider hanger to be placed next to concrete.
4. Before tack welding as noted, actual barrier dimensions are to be checked to assure flush fit. Top ⅞" bracket bolts must be in place before Beam Hangers are tack welded.
5. Contractor may submit alternative details for approval.
6. For details not shown see Standard Plan A75-A.5.
DESIGN
DETAILS Paul Gregory
QUANTITIES
State of CALIFORNIA
DEPARTMENT OF TRANSPORTATION
STRUCTURES - DESIGN
CONCRETE BARRIER TYPE 50
STEEL CHANNEL CLOSURE DETAIL

Figure 10A

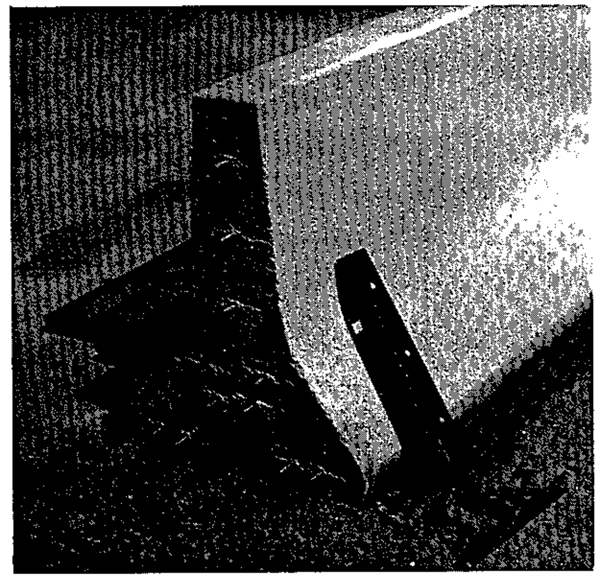
Gap Beam Installation Procedure

After the barrier end anchor has been placed and cured and the beam hangers have been cut from salvaged channel, the following installation procedure should be followed:

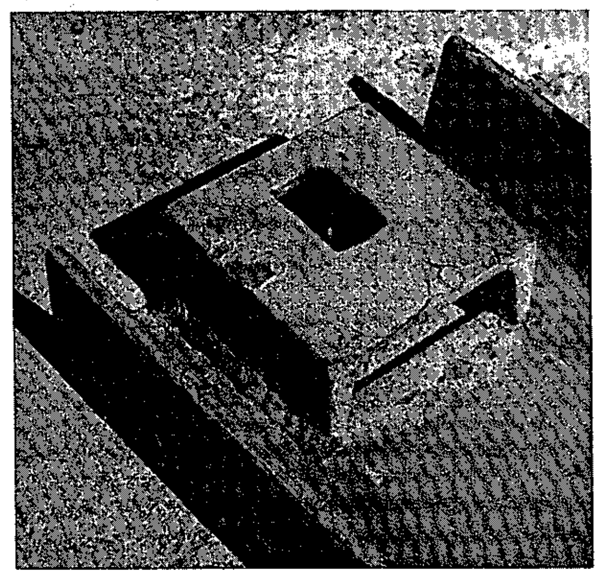
1. Clamp right and left upper beam hanger together (left hanger on top of right hanger). Top and bottom dimensions should be 2-1/4 inch and 6-1/4 inch respectively. Drill 1/8 inch pilot hole for 1-1/8 inch x 1-5/8 inch slots. Cut slots with a torch.

2. Measure and cut channel beams to length with specified tolerance. Weld steel bar on bottom beams.

3. Cut 2 inch x 2-1/2 inch slots in channel beams and 3/4 inch x 1-1/4 inch slots in brackets, C3x4.1, and weld brackets to channels.

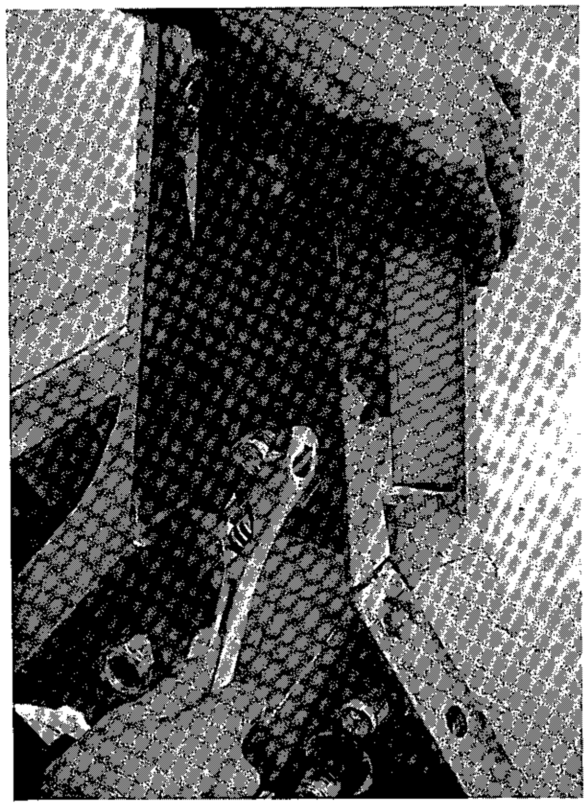


Barrier end anchor



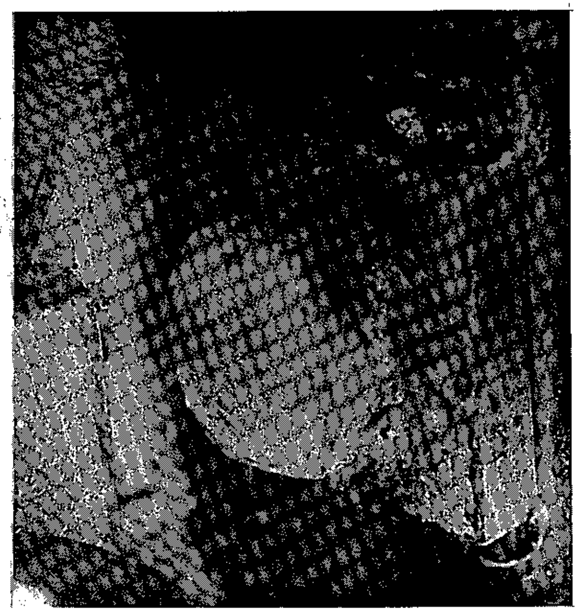
C3x4.1 brackets welded to channels

4. Place upper beam hangers over threaded rods embedded in barrier. After placing nuts on to hold hangers in place, adjust right and left hanger so there is 1-7/8 inch from face of hanger to outside edge of barrier. Mark hangers for tack welding. Determine placement of 5/8 inch bolts for channel beam location. Mark and drill 11/16 inch holes.



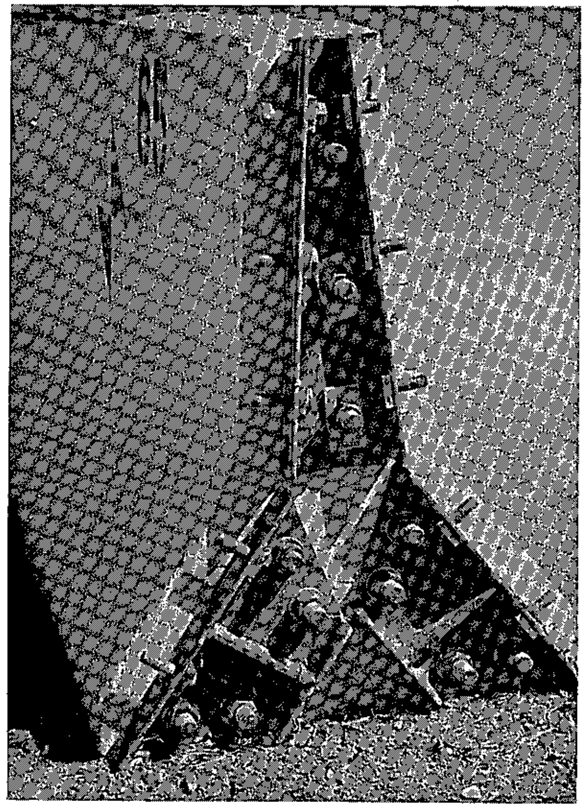
Upper beam hanger adjustment

5. Tack weld 5/8 inch bolts and bevel washers to upper and lower beam hangers before tack welding right and left upper beam hangers together. (If upper beam hanger is tack welded before bolts are welded on, the bolts cannot be placed in top holes.)



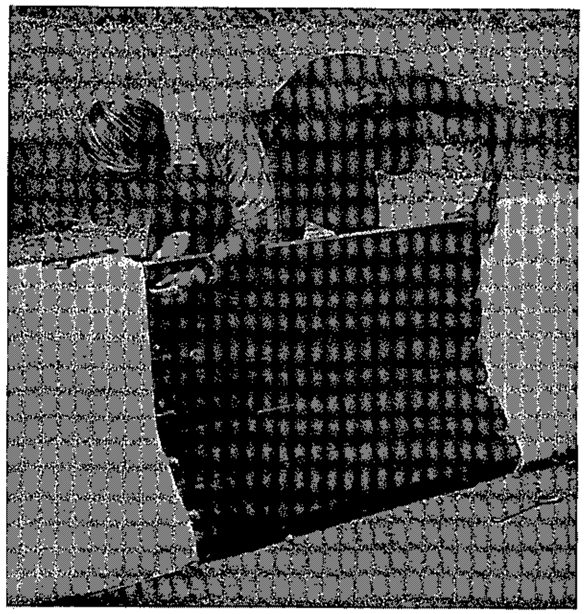
Tack welded bolts and washers

6. Bolt the upper and lower beam hangers snugly ("wrench tight") onto barrier. Before bolting on the channel beams check to make sure they fit flush with outside face of barrier. If they do not, adjust beam hangers.

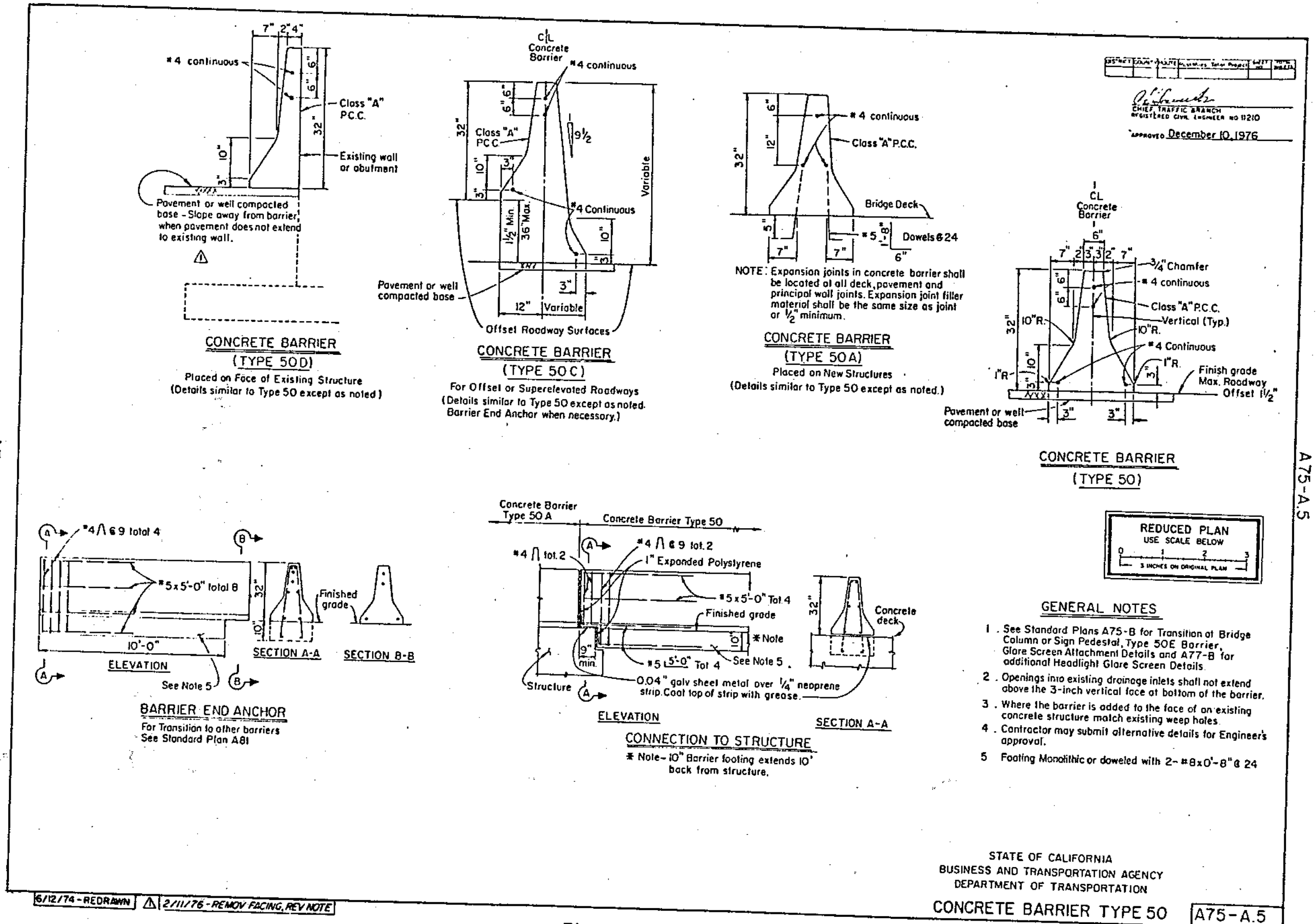


Upper and lower beam hangers bolted to barrier

7. Bolt channel beams snugly onto hangers, using specified spacing of beams.



Bolting channel beams to hangers



7" 2" 4"
#4 continuous
6" 6"
32"
Class "A" P.C.C.
10"
3"
Existing wall or abutment
Pavement or well compacted base - Slope away from barrier when pavement does not extend to existing wall.
CONCRETE BARRIER
(TYPE 50D)
Placed on Face of Existing Structure
(Details similar to Type 50 except as noted)
CL Concrete Barrier
#4 continuous
Class "A" PCC
9½
#4 Continuous
1½" Min.
36" Max.
Variable
Pavement or well compacted base
12"
Variable
Offset Roadway Surfaces
CONCRETE BARRIER
(TYPE 50C)
For Offset or Superelevated Roadways
(Details similar to Type 50 except as noted. Barrier End Anchor when necessary.)
#4 continuous
Class "A" P.C.C.
Bridge Deck
5"
7"
#5 1'-8"
Dowels @ 24
6"
NOTE: Expansion joints in concrete barrier shall be located at all deck, pavement and principal wall joints. Expansion joint filler material shall be the same size as joint or ½" minimum.
CONCRETE BARRIER
(TYPE 50A)
Placed on New Structures
(Details similar to Type 50 except as noted.)
CHIEF TRAFFIC BRANCH
REGISTERED CIVIL ENGINEER NO 11210
APPROVED December 10, 1976
CL Concrete Barrier
6"
7" 2" 3" 3" 2" 7"
¾" Chamfer
#4 continuous
Class "A" P.C.C.
Vertical (Typ.)
10"R.
#4 Continuous
1"R.
Finish grade
Max. Roadway Offset 1½"
Pavement or well compacted base
3"
CONCRETE BARRIER
(TYPE 50)
REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN
#4 ∩ @ 9 total 4
#5x5'-0" total 8
10'-0"
ELEVATION
See Note 5
SECTION A-A
Finished grade
SECTION B-B
BARRIER END ANCHOR
For Transition to other barriers See Standard Plan A81
Concrete Barrier Type 50 A
Concrete Barrier Type 50
#4 ∩ tot. 2
#4 ∩ @ 9 tot. 2
1" Expanded Polystyrene
#5x5'-0" Tot. 4
Finished grade
✱Note
See Note 5
#5 5'-0" Tot 4
9" min.
Structure
0.04" galv sheet metal over ¼" neoprene strip. Coat top of strip with grease.
ELEVATION
Concrete deck
SECTION A-A
CONNECTION TO STRUCTURE
✱ Note - 10" Barrier footing extends 10' back from structure.
GENERAL NOTES
1. See Standard Plans A75-B for Transition at Bridge Column or Sign Pedestal, Type 50E Barrier, Glare Screen Attachment Details and A77-B for additional Headlight Glare Screen Details.
2. Openings into existing drainage inlets shall not extend above the 3-inch vertical face at bottom of the barrier.
3. Where the barrier is added to the face of an existing concrete structure match existing weep holes.
4. Contractor may submit alternative details for Engineer's approval.
5. Footing Monolithic or doweled with 2-#8x0'-8" @ 24
STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF TRANSPORTATION
CONCRETE BARRIER TYPE 50
A75-A.5
6/12/74 - REDRAWN
2/11/76 - REMOV FACING, REV NOTE

Figure 11A